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# Academic engagement and commercialisation: A review of the literature on university–industry relations

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ABSTRACT

A considerable body of work highlights the relevance of collaborative research, contract research, consulting and informal relationships for university–industry knowledge transfer. We present a systematic review of research on academic scientists' involvement in these activities to which we refer as 'academic engagement'. Apart from extracting findings that are generalisable across studies, we ask how academic engagement differs from commercialisation, defined as intellectual property creation and academic entrepreneurship. We identify the individual, organisational and institutional antecedents and consequences of academic engagement, and then compare these findings with the antecedents and consequences of commercialisation. Apart from being more widely practiced, academic engagement is distinct from commercialisation in that it is closely aligned with traditional academic research activities, and pursued by academics to access resources supporting their research agendas. We conclude by identifying future research needs, opportunities for methodological improvement and policy interventions.



## 1. Introduction

Universities are organisations that perform a key role within contemporary societies by educating large proportions of the population and generating knowledge. Recently, often on the initiative of policy-makers, many universities have taken action to develop a 'third mission' by fostering links with knowledge users and facilitating technology transfer (Etzkowitz et al., 2000b; Florida and Cohen, 1999; Gulbrandsen and Slipersæter, 2007).

Amongst the various channels available for establishing these links, the commercialisation of academic knowledge, involving the patenting and licensing of inventions as well as academic entrepreneurship, has attracted major attention both within the academic literature and the policy community (O'Shea et al., 2008; Phan and Siegel, 2006; Rothaermel et al., 2007). Commercialisation is considered a prime example for generating academic impact because it constitutes immediate, measurable market acceptance for outputs of academic research (Markman et al., 2008). To support commercialisation, many universities have established specialised structures, such as technology transfer offices (TTOs), science parks and incubators (Clarysse et al., 2005; Siegel et al., 2003), and created supportive internal rules and procedures (Thursby et al., 2001).

Whilst commercialisation clearly represents an important way for academic research to contribute to economy and society,

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there are multiple other ways in which university research is transferred (Salter and Martin, 2001). In this paper, we focus on 'academic engagement' which we define as knowledge-related collaboration by academic researchers with non-academic organisations. These interactions include formal activities such as collaborative research, contract research, and consulting, as well as informal activities like providing ad hoc advice and networking with practitioners (Abreu et al., 2009; Bonaccorsi and Piccaluga, 1994; D'Este and Patel, 2007; Meyer-Krahmer and Schmoch, 1998; Perkmann and Walsh, 2008). Academic engagement is also sometimes referred to as informal technology transfer (Link et al., 2007), even though most of these interactions tend to be formalised using contracts.

Academic engagement represents an important way in which academic knowledge is transferred into the industrial domain; many companies consider it significantly more valuable than licensing university patents (Cohen et al., 2002). Universities' income from academic engagement is usually a high multiple of the income derived from intellectual property (Perkmann et al., 2011). It should be added that academic engagement is not a new phenomenon but has a long tradition, particularly at universities that emphasise practical and technical relevance as part of their mission, such as the US land grant universities who seek to provide practical education whilst assisting local firms and agricultural contexts (Mowery and Nelson, 2004). Perhaps mirroring the recent policy and research interest in commercialisation, however, there has been a surge in research published on this topic, yet the state of knowledge remains relatively fragmented and tentative. In addition, there have been few efforts to underpin academic engagement conceptually, which stands in contrast to commercialisation where entrepreneurship theory has been applied.

We address these gaps by presenting a systematic review of the literature on academic engagement. The research question guiding our review is: What are the antecedents and consequences of academic engagement? We will consolidate results from all existing studies and extract generally applicable results. In a further step, we compare our findings with what is known about the antecedents and consequences of commercialisation, i.e. intellectual property creation and academic entrepreneurship (Rothaermel et al., 2007). This analysis allows us to address whether academic engagement is driven by the same mechanisms as commercialisation, or whether it represents a conceptually different type of phenomenon that needs to be treated separately by researchers and policy-makers.

Our work adds to existing research in four important ways. We provide the first systematic review of academic engagement and compare the latter with commercialisation. We paint a comprehensive picture of the antecedents and consequences of academic engagement across various contexts. Our approach allows us to separate factors and boundary conditions that may be idiosyncratic and the patterns that apply to the phenomenon more generally. We also identify aspects that are either less well researched or contested, providing direction for future research.

Second, we synthesise our empirical results into a novel theoretical framework on academic engagement. We outline both the differences and overlaps between academic engagement and academics' involvement in commercialisation and thereby hope to facilitate a convergence between these two streams of the literature.

Third, we make a methodological contribution, by discussing why studying academic engagement requires methodological approaches that differ from those for studying commercialisation. We also identify the challenges posed by these approaches and suggest how they may be overcome.

Fourth, our results are policy-relevant. In the last 30 years, universities have experienced major changes that have affected their objectives, sources of funding and modes of operation (Geuna, 2001; McKelvey and Holmén, 2009). There have been important modifications in universities' policy environments due to initiatives such as the Bayh–Dole Act of 1980 in the US, and the abandonment of the 'professor's privilege' in most European countries (Baldini et al., 2006; Grimaldi et al., 2011; Lissoni et al., 2008; Mowery et al., 2001). For policy-makers, it is important to know whether academic engagement is driven by similar mechanisms to commercialisation, or affected by factors that may not be activated by entrepreneurial incentives.

## 2. Conceptual background

Here we clarify the concept of academic engagement, and its relationship to the concept of commercialisation. Academic engagement is characterised by the following aspects which refer to organisation and objectives, respectively. First, academic engagement represents inter-organisational collaboration instances, usually involving 'person-to-person interactions' (Cohen et al., 2002), that link universities and other organisations, notably firms (Bonaccorsi and Piccaluga, 1994; Meyer-Krahmer and Schmoch, 1998; Schartinger et al., 2002). The quid-pro-quo agreed amongst the partners may be purely financial, i.e. the academic may work for a fee, or may consist of non-financial benefits such as access to materials or data for academic research projects or ideational input (Mansfield, 1995; Perkmann and Walsh, 2009; Senker, 1995). Second, generally the partners pursue goals that are broader than the narrow confines of conducting research for the sake of academic publishing, and seek to generate some kind of utility for the non-academic partners. For instance, the academic may offer his/her expertise to provide new ideas on application-oriented issues, solve problems and suggest solutions to collaborating organisations.

How does academic engagement relate to commercialisation? First, in terms of organisation, while academic engagement represents collaboration, commercialisation – or 'technology transfer' – may occur via academic entrepreneurship, that is the founding of a firm with the objective to commercially exploit a patented invention, or in some cases, a body of unpatented expertise (Shane, 2004). Alternatively, a patented or otherwise protected invention may be licensed out against the contracted receipt of royalties (Jensen and Thursby, 2001). For both processes, patenting represents a preliminary step, indicating a disposition on the part of the academic towards some kind of exploitation. Second, commercialisation means an academic invention is exploited with the objective to reap financial rewards; by contrast, academic engagement is broader and is pursued for varying objectives.

Despite these differences, there are important links and overlaps between both types of activity. In fact, commercialisation is often an outcome or follow-on activity, whether intended or unintended, of academic engagement. Working on common projects with industry may provide academics with insights into what ideas may be commercially valuable, and hence the opportunity to develop or co-develop inventions that can be patented, licensed or enable an academic spin-off. In other words, academic engagement often precedes commercialisation in time and can hence be regarded as an input factor to the latter. It some cases, it may also accompany commercialisation, for instance when spin-off companies work collaboratively with the university labs they originated from (Meyer, 2003).

Both academic engagement and commercialisation tend to be individually driven and pursued on a discretionary basis. Universities are 'professional bureaucracies' (Mintzberg, 1979) that rely on the independent initiative of autonomous, highly skilled professionals to reach their organisational goals. While academic entrepreneurship – as well as patenting as an often used proxy for entrepreneurial behaviour – are also primarily individual

behaviours, licensing can be carried out by the university without the active participation of the academic inventor even though such participation enhances the probability of commercial success (Agrawal, 2006).

## 3. Methodology

We performed a systematic review of the available evidence on academic engagement. Such a literature review establishes the state of current knowledge in a field (Tranfield et al., 2003). In medical fields, such reviews synthesise empirical evidence from large numbers of studies and identify areas of consensus and disagreement between researchers within certain areas of research. This principle can be fruitfully adopted in the social sciences although the overall number of existing studies tends to be smaller, measures and variables are less tightly defined and conclusions may be more contestable. For the current article, we followed a simplified version of the process outlined by Tranfield et al. (2003) which we detail below.

Our objective was to establish what is known about (a) the extent and types of academic engagement, (b) its determinants, and (c) its impact on academics, universities and other stakeholders. We focused our analysis on individual researchers because the decision to engage is a decision that, in the university context, is primarily taken on an individual level.

We applied the following procedure. We first identified all the relevant research published on this topic from 1980 to 2011. We conducted an extensive search in the titles and abstracts of published, peer-reviewed articles held by the bibliographical database service EBSCO (EconLit included), using a series of keywords that the research team had identified (Appendix A). Subsequently, we performed a manual search of the journals with the highest article counts over the past 22 years (1989–2011): *Research Policy*, *Journal of Technology Transfer, and Technovation*. This procedure allowed us to exclude possible bias towards newer studies and also to validate the search terms, given that there is little consensus on the keywords used for classifying articles on academic engagement.

The above procedure yielded 413 results. We first filtered this list according to fit. As we were particularly interested in studies using data on individual researchers, we removed all articles that did not fulfil this criterion. For example, we discarded studies at the aggregate level of department, university or country, case studies of specific universities that referred only to the organisational context and historical analyses. We also excluded surveys of researchers who had left academia, and articles dealing solely with commercialisation rather than engagement. This procedure eliminated 280 articles. We subsequently screened the remaining articles, applying basic quality criteria to ascertain whether data had been collected in a systematic way and whether papers proposed intelligible results. At this stage we also eliminated those articles that had a strong practitioner focus but contained little tangible data. This procedure left us with a total of 36 articles.

At this stage, we read and synthesised each remaining article, compiling the following information in tabular form (Pawson, 2006): research questions, data used, methodology, variables, and findings (Appendix B). We synthesised this information into a preliminary report and held a full-day workshop, with all the authors present, to debate the findings and implications of our discoveries and used the results from the workshop to revise the report.

The majority of articles we considered were published in the period from 2006 onwards (Fig. 1). In their review, which covered a 25-year period up to 2005, Rothaermel et al. (2007), noted that the literature on university entrepreneurship neglected the analysis of individual researchers' involvement in the process. Indeed, the number of articles addressing particularly academic engagement has increased significantly since 2005, strengthening the case for

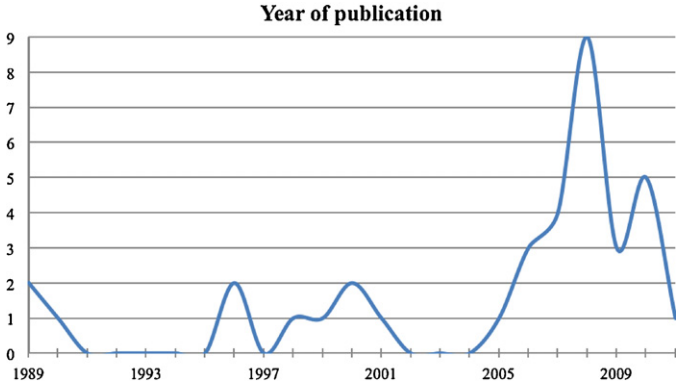


**Fig. 1.** Articles published per year. For 2011, the graph shows the number of publications for January to March only.

carrying out a fresh literature review (Perkmann and Walsh, 2007; Phan and Siegel, 2006; Rothaermel et al., 2007). Regarding the journals in which these articles are published we observe a skewed distribution (Table 1): two journals (*Research Policy* and *Journal of Technology Transfer*) account for 63% of all output. Other outlets include medical and education journals while articles in general management, economics and sociology journals are relatively rare. Whilst these latter journals emphasise theory building and theory testing, research on academic engagement has produced predominantly phenomenon-focused studies.

As a final step in our analysis, we systematically compared the results obtained on academic engagement with what is known about academics' involvement in commercialisation, i.e. academic entrepreneurship and IP-related activities. Unlike academic engagement, research on commercialisation has previously been systematically documented and synthesised by published reviews (Geuna and Muscio, 2009; Larsen, 2011; Phan et al., 2005; Rothaermel et al., 2007) and we therefore use that literature for our comparison.

## 4. Findings

In this section, we present the findings from the systematic review. Each subsection details a specific aspect of academic engagement and we also report how this compares with commercialisation.

Synthetic results are presented in Table 2.

### 4.1. Extent of academic engagement

Academic engagement is varied and includes collaborative research, contract research, consulting and other forms of

**Table 1**
Synthesis of articles.

| | Number of articles |
|---|---|
| Research Policy | 13 |
| The Journal of Technology Transfer | 10 |
| Technovation | 3 |
| The Journal of Higher Education | 2 |
| Others | 8 |
| Quantitative data | 33 |
| Qualitative data | 3 |
| US | 18 |
| UK | 5 |
| Other Europe | 11 |
| Asia | 1 |
| Other countries | 1 |
| Sum | 36 |

Breakdown of articles according to journal, type of data, and empirical focus.

**Table 2**
Comparison between academic engagement and commercialisation.

| Variable | Engagement | Commercialisation |
|---|---|---|
| Individual determinants | | |
| Male | + | + |
| Age | o | o |
| Seniority | + | o |
| Previous commercialisation experience | o | + |
| Grants awarded (government) | + | o |
| Contracts awarded (industry) | + | o |
| Scientific productivity | + | + |
| Organisational determinants | | |
| Quality university/department | – | + |
| Organisational support | o | + |
| Incentive system | o | o |
| Organisational commercialisation experience | o | + |
| Peer effects | o | + |
| Institutional determinants | | |
| Applied discipline | + | + |
| Life-science/biotech | o | + |
| Country-specific regulations/policy | o | + |
| Impact | | |
| Scientific productivity | o | + |
| Commercial productivity | o | n/a |
| Shift towards applied research | o | o |
| Increased secrecy | o | + |
| Collaborative behaviour | + | + |
| Teaching | o | o |

Notes: The table reports the effects of independent variables (vertical) on outcome variables (individual-level academic engagement and commercialisation). Commercialisation includes academic entrepreneurship and IP-based technology transfer. Key: (+) Positive effect in at least some studies. (−) Negative effect in at least some studies. (o) ambiguous effect/not enough empirical evidence. (n/a) not applicable.

knowledge exchange (D'Este and Patel, 2007; Louis et al., 1989; Nilsson et al., 2010; Schartinger et al., 2002). In Table 3, we report the proportion of academics engaged in diverse types of activities in some of the studies reviewed.

For instance, almost half of UK investigators in the physical and engineering sciences engaged in collaborative research, contract research or consulting at least once over a two-year period while 12% and 22% engaged in academic entrepreneurship and patenting respectively (D'Este and Perkmann, 2011). According to an older US study, the supplemental income of academic life scientists gained from consulting amounted to around 10% of their salaries, with fewer than 5% of respondents reporting consulting income of over 40% of their salaries (Louis et al., 1989). Median research income from industry grants as a proportion of total grants of respondents was approximately 8% (Louis et al., 1989). According to the Research Value Mapping Survey, 17% of academics at US research-intensive universities obtained an industry grant in the 12 months preceding the survey while 18% consulted with a firm (Bozeman and Gaughan, 2007). Similarly, in Germany 20% of academics published jointly with industrial partners and 17% served as formally paid consultants in the 12 months preceding the survey (Grimpe and Fier, 2010). A similar figure for consulting is obtained by Haeussler and Colyvas (2011) for German and UK life scientists. According to a comparative study of science, engineering and medicine faculty in Sweden and Ireland, 51–68% of respondents were involved in "soft" collaboration activities, such as consulting, while 12–19% engaged in spin-off creation at least once during their academic career (Klofsten and Jones-Evans, 2000).

Given these differences in participation rates, it appears worth investigating the determinants of academic engagement behaviours and what consequences these behaviours have for the traditional activities of research and teaching.

Unlike academic engagement, fewer academics are involved in commercialisation. Lissoni et al.'s (2009) report for three European countries showed that in the total population of academics, approx. 4–5% of individuals had filed a patent. A roughly equivalent figure for the US is provided by the Research Value Program, with about 5% (Bozeman and Gaughan, 2007). In the studies we reviewed the proportion of academics involved in patenting ranges from 5% to 40%, due to different sampling strategies, illustrating how patenting rates vary strongly with scientific discipline, as well as university culture (Agrawal and Henderson, 2002). The proportion of academics taking part in a commercial enterprise in the studies we reviewed was generally below 10%; here we see, however, equally large differences for specific samples, such as certain departments at Stanford (Kenney and Goe, 2004). Despite these outliers, it can be established that the proportion of academics involved in academic

**Table 3**
External engagement: comparison across different studies.

| | Population | Time frame analysed | Collaborative research | Consulting | Sponsored research | Contract research | Patenting | Academic entrepreneurship |
|---|---|---|---|---|---|---|---|---|
| Klofsten and Jones-Evans (2000) | Academics in Sweden | Entire career | | 51% | 44% | 45% | 12% | 12% |
| Klofsten and Jones-Evans (2000) | Academics in Ireland | Entire career | | 68% | 68% | 69% | 26% | 19% |
| Gulbrandsen and Smeby (2005) | Tenured university professors in Norway | 5 years | 21% | 31% | 21% | | 7% | 7% |
| Bozeman and Gaughan (2007) | Academic at US researcher universities | 12 months | 17% | 18% | | | 5% | 3% |
| D'Este and Perkmann (2011) | UK Physical & Engineering Sciences Investigators | 2 years | 44% | 38% | | 47% | 22% | 12% |
| Grimpe and Fier (2010) | Academics in Germany | 12 months | 20% (joint publications) | 17% | | | | |
| Haeussler and Colyvas, 2011 | Life scientists in Germany and UK | 12 months | | 20% | | | 40% | 9% |

The figures indicate the percentage of academics involved in the specified activities unless otherwise indicated, according to different studies. Figures on patenting and academic entrepreneurship are included for comparison.

engagement is generally a multiple of individuals involved in commercialisation. This means a significant proportion of academics pursue academic engagement, without conducting commercialisation.

### 4.2. Antecedents of external engagement

#### 4.2.1. Individual characteristics

Individual characteristics play an important role in predicting academic engagement. Male academics are significantly more likely to engage with industry (Azagra-Caro, 2007; Boardman, 2008; Giuliani et al., 2010; Goktepe-Hulten, 2010; Link et al., 2007). Age has an ambiguous effect, even when controlling for seniority. Some studies find a positive relationship (Boardman and Ponomariov, 2009; Haeussler and Colyvas, 2011; Link et al., 2007), while others find a negative relationship (Bekkers and Bodas Freitas, 2008; D'Este and Patel, 2007; D'Este and Perkmann, 2011; Giuliani et al., 2010) or no relationship at all (Boardman and Ponomariov, 2009; Gulbrandsen and Smeby, 2005; Renault, 2006). The negative impact of age found by some studies may reflect a training effect: individuals who were trained in earlier periods when universities' engagement with industry was less relevant or even discouraged, may be attached to norms not compatible with collaboration with private companies (Bercovitz and Feldman, 2008).

By contrast, seniority is often positively related to collaboration (Boardman, 2008, 2009; Boardman and Corley, 2008; Bozeman and Gaughan, 2007; D'Este and Perkmann, 2011; Haeussler and Colyvas, 2011; Link et al., 2007; Ponomariov, 2008). Given that engagement is often seeded by personal contacts, more experienced researchers are likely to have larger networks, and hence more social capital, enabling them to find potential partners in the private sector (Giuliani et al., 2010; Haeussler and Colyvas, 2011; Landry et al., 2006). Such network effects are reinforced by routine interaction with industry partners. Previous experience with industrial collaborators positively affects the attitudes of academics towards industry (Van Dierdonck et al., 1990) and also their collaborative behaviour (D'Este and Patel, 2007). These findings are supported by the observation that previous experience with commercialisation, patenting or venture creation increases the likelihood of academics' participation in collaborative activities (Bekkers and Bodas Freitas, 2008).

A further individual characteristic predicting academic engagement is related to scientists' quality and success. Academics' scientific productivity is generally positively related to engagement (Bekkers and Bodas Freitas, 2008; Gulbrandsen and Smeby, 2005; Haeussler and Colyvas, 2011; Louis et al., 1989). In other words, the best and most successful scientists are also those who engage most with industrial partners. In addition, individuals' ability to mobilise resources for their research is also positively linked to collaboration with industry. Various studies find complementarities between academics' volume of government grants and funds raised from industry (Boardman, 2009; Boardman and Ponomariov, 2009; Bozeman and Gaughan, 2007; Lee and Bozeman, 2005; Link et al., 2007). Grant funding is predominantly based on a peer-review process and is therefore indicative of the scientist's success in the field. It appears that scientists' productivity and success in fund raising acts as a signal for private companies when identifying potential collaborators, leading to more opportunities and consequently more engagement activities. Moreover, the ability to acquire public resources may indicate a general ability to attract funds, which will also increase the likelihood of moving into collaborative projects with industry. This dynamic may however also be driven by the increasing tendency of government funding agencies to look positively upon grant proposals that involve industry interaction.

When comparing academic engagement with commercialisation, individual determinants play a similar role for both sets of activities. Notably, male researchers are more likely to engage in both, while the role of age appears to be ambiguous for both engagement and commercialisation. Importantly, both engagement and commercialisation are more likely to be pursued by individuals that are more scientifically productive than their colleagues. However, academic engagement is clearly associated with higher seniority and success in obtaining government grants while for commercialisation the role of these factors is ambiguous. Some studies suggest that engagement in commercialisation behaviour may be associated with being younger because the lower age range were socialised in contexts where commercialisation had become more legitimate (Bercovitz and Feldman, 2008).

#### 4.2.2. Organisational context

The most salient organisational-level determinant for academic engagement is represented by the quality of academics' university or department. The overall effect of organisation-level academic quality on participation in collaboration activities appears to be negative (D'Este and Patel, 2007; Ponomariov, 2008; Ponomariov and Boardman, 2008). To some extent, the finding that faculty support for university–industry interaction is negatively influenced by the age of their university points in a similar direction (Azagra-Caro et al., 2006). This result seems counterintuitive when compared to the findings on the impact of individual scientific quality, but may arguably be related to a lower degree of resource munificence at lower quality research institutions, motivating academics to embrace industry collaboration as a means of acquiring research funds.

Organisational factors are likely to moderate the impact of individual characteristics on external engagement. Louis et al. (1989) found that individual characteristics are strongly moderated by the effect of group-level norms. These findings are backed by more recent research on UK and German scientists (Haeussler and Colyvas, 2011). If their colleagues value patents and awards, academics are more likely to consult for private companies, while the opposite is true if their peers value traditional academic values.

Finally, academics' affiliation with special entities within their universities, such as research centres, has been found to positively influence engagement (Bozeman and Gaughan, 2007). New organisational structures drawing on expertise from multiple fields appear to be instrumental in facilitating interactions between the public and private sector.

With respect to organisational determinants, there are pronounced differences between academic engagement and commercialisation. An extensive literature has analysed the role of university and departmental features (Owen-Smith and Powell, 2001) and technology transfer infrastructures (Lockett and Wright, 2005; Siegel et al., 2003) for commercialisation. This has shown that the research quality of the affiliate university increases the likelihood of researchers participating in commercialisation (Di Gregorio and Shane, 2003; Mansfield, 1995; O'Shea et al., 2005; Owen-Smith and Powell, 2001; Sine et al., 2003). Moreover, the presence of formal technology transfer mechanisms is generally positively related to commercialisation (Markman et al., 2005a, b; Phan and Siegel, 2006). Research has also found local peer effects imply that academics are more likely to be entrepreneurial if departmental colleagues of the same rank are entrepreneurial (Bercovitz and Feldman, 2008; Stuart and Ding, 2006). For academic engagement, these relationships do not appear to hold. Most notably, in contrast to commercialisation, individual academic engagement tends to be negatively correlated with the research quality of departments or universities. Simultaneously, there is no conclusive evidence on the role of formal organisational

support structures or peer effects for stimulating academic engagement.

#### 4.2.3. Institutional context

We consider two aspects of the institutional context in which academics operate: the affiliation to a scientific discipline and the effect of specific national regulations and public policies. Both factors inform academic engagement as they shape the norms and rules relevant for researchers, either because they are official government regulations or because they are the rules of conduct prevailing within the 'invisible colleges' in which academics operate (Crane, 1972).

Disciplinary affiliation is an important variable informing engagement with industry (Bekkers and Bodas Freitas, 2008; Martinelli et al., 2008). Applied fields of research, such as engineering, make collaboration or engagement in entrepreneurial activities more likely (Bekkers and Bodas Freitas, 2008; Boardman, 2008, 2009; Bozeman and Gaughan, 2007; Lee and Bozeman, 2005; Lee, 1996; Ponomariov, 2008). Scientific disciplines affect the selection of knowledge transfer channels from university to firms: Bekkers and Bodas Freitas (2008) find that in biomedical and chemical engineering the most important channels are patents and licensing, scientific output, students' placements, informal contacts and contract research. For researchers in computer science, patents and licenses do not seem a relevant transfer channel, while they are very important for material scientists. Finally, in social sciences, knowledge seems to be transferred through personal contacts and labour mobility. In the medical field, clinical researchers are more likely to partner with industry but the non-clinical researchers are more likely to commercialise (Louis et al., 2001).

In terms of the role of national policies, comparative empirical evidence is limited. Most studies focus on North American and European countries including the UK, Spain, Germany and Sweden while little is known about other geographical contexts. At least among these countries, there appear to be no major differences in the determinants of academic engagement found in comparisons of the UK and Germany (Haeussler and Colyvas, 2011), Germany and US (Grimpe and Fier, 2010), or Sweden and Ireland (Klofsten and Jones-Evans, 2000). Lee (1998) speculates that increased academic engagement, rooted in the US academic career system, provides incentives to academics to acquire resource from industry in order to further their career. Such institutional pressures may be lower in systems where funding is allocated on a less competitive basis and where university positions are endowed with discretionary funds (Haeussler and Colyvas, 2011).

Again comparing academic engagement with commercialisation, a large body of evidence exists on institutional-level determinants of the latter, due to the presence of clear policy changes such as the Bayh–Dole Act in the US and the abolition of the so-called 'professor's privilege' in European countries (Mowery and Sampat, 2005; Powers and McDougall, 2005; Sampat et al., 2003). Mowery and co-workers argue that the rapid growth in university patenting in the period following the Bayh–Dole Act is partly due to the supply of technological opportunities in scientific fields such as in biomedicine. Authors comparing different institutional contexts found that commercialisation of university inventions is more likely in environments characterised by intense competition (such as in the US) while more rigid environments discourage these initiatives (Goldfarb and Henrekson, 2003; Henrekson and Rosenberg, 2001). By contrast, research on academic engagement has rarely addressed the role of institutional environments and national policies, partly because it has enjoyed less attention from policy-makers than commercialisation.

### 4.3. Consequences of academic engagement

Academic engagement can have an impact on various university activities. A first issue concerns the effect of engagement on academics' research productivity. Most authors find that faculty with industrial support publish at least as many scientific articles as their colleagues, if not more (Blumenthal et al., 1996; Gulbrandsen and Smeby, 2005). Collaborative projects often yield new, academically valuable insights and ideas even if they are relatively applied and do not directly result in publishable results (Lee, 2000; Mansfield, 1995; Perkmann and Walsh, 2009). However, there is also evidence that researchers with industrial exposure may publish less over their career as a whole, and that publishing may have an inverse U-shape-relationship with engagement (Lin and Bozeman, 2006).

A second issue refers to the impact of external engagement on academic scientists' research agendas. Some observers fear that engagement with industry shifts researchers' agendas towards more applied topics at the expense of the long-term benefits of basic science. For example, Blumenthal et al. (1996) in their study of US life science faculty showed that academics with industry support are more likely to report that their choice of research topic is influenced by the project's commercial potential. Evidence indicates that industry-funded research is more applied, but also more collaborative, both with private and public partners (Boardman and Corley, 2008; Gulbrandsen and Smeby, 2005). A bibliometric study (Godin and Gingras, 2000) reported no evidence of industrial influence on the direction of research. Third, academics involved in engagement activities may restrict communication with their colleagues. Empirical evidence to support this statement is rather limited, with only one quantitative and one qualitative study reporting a positive relationship between engagement and secrecy (Blumenthal et al., 1996; Welsh et al., 2008).

The impact of academics' engagement with industry on teaching is not clear and the question has not been addressed in the literature. The only exception is Lin and Bozeman (2006), who observe that academics with industry exposure support more students.

Turning again to the impact of commercialisation activities, there is relative agreement that academic inventors publish more and better papers than their non-patenting colleagues (Agrawal and Henderson, 2002; Azoulay et al., 2007; Breschi et al., 2007; Fabrizio and Di Minin, 2008). Although involvement in commercialisation may not directly impact on scientists' academic careers, they believe it can increase their prestige and reputation (Moutinho et al., 2007; Owen-Smith and Powell, 2001; van Rijnsoever et al., 2008). Concerning the possible shift of research towards more applied topics, Hicks and Hamilton (1999) found that the share of basic research at US universities remained unchanged between 1981, the year in which the Bayh–Dole Act was passed, and 1995 while university patenting increased significantly. Thursby and Thursby (2002) found that increases in university licensing were largely due to universities' greater commercialisation efforts rather than changes in research direction.

Finally, there is some evidence that academic researchers involved in commercialisation activities practice higher degrees of secrecy than their non-commercialising colleagues (Campbell et al., 2000, 2002) and that academic entrepreneurship may hamper the accumulation of knowledge in the public domain (Toole and Czarnitzki, 2010). Related research suggests that increased academic patenting may slow the unencumbered diffusion of academic knowledge (Huang and Murray, 2009; Murray and Stern, 2007). Most research on this issue focuses on commercialisation in the life sciences because here, intellectual property is of high potential value. This limited evidence suggests, however, that academic researchers with an interest in commercialisation may employ greater levels of secrecy about their research results than their open science oriented colleagues.

Comparing the consequences of individual involvement in commercialisation with the consequences of academic engagement, we can conclude the following. First, whilst participation in commercialisation appears to have positive effects on research productivity, the evidence for academic engagement is ambiguous. Second, neither commercialisation nor engagement seems to skew academics' research towards more applied topics. Thirdly, there is tentative yet no conclusive evidence that both types of industry exposure lead to increased secrecy and restricted communication of open research findings.

## 5. Discussion

### 5.1. Implications for the concept of academic engagement

The systematic literature review and comparison with extant research on commercialisation enable us to further develop the concept of academic engagement. This type of university–industry link may take different forms, including collaborative research, contract research and consulting, and is practiced by a far larger proportion of academics than commercialisation. The review suggests that academic engagement is a multi-level phenomenon, in the sense that it is determined by both the characteristics of individuals as well as the organisational and institutional context in which they work. Below, we synthesise our findings with a view to developing a fuller understanding of this phenomenon.

On the individual level, academic engagement is pursued by scientists who are well established and well connected in the academic community. Individuals who are more senior, have more social capital, more publications and more government grants, also work most prolifically with industrial collaborators. Particularly the positive correlation between engagement and government grants, and engagement and scientific productivity found by most studies, suggests that academic engagement goes hand-in-hand with academic success. Engagement appears to be part of the activities responsible for the 'Matthew effect' in academia, according to which individual success is reinforced through a virtuous cycle of achievements and returns on those achievements (Merton, 1968). This pattern also chimes with the result that male academics are more likely to engage with industry, mirroring the insight obtained from other studies suggesting that male scientists occupy more prominent positions than women and are hence in a better position to mobilise resources and establish wider networks (Etzkowitz et al., 2000a; Gupta et al., 2005; Murray and Graham, 2007). The positive correlation between academic success and engagement demonstrates that engagement is highly complementary with strictu sensu academic activities, i.e. publishing and writing grants. For commercialisation, the degree of complementarity with academic activities is less clear cut; while commercialisation tends to be positively related to scientific productivity, there is a contingent relationship with grant and contracts (Table 2).

Evidence presented by research on the attitudinal and motivational aspects of both academic engagement and commercialisation supports a view of academic engagement as complementary to academic research. Lee (1996) investigated the attitudes of US academic researchers towards 'university entrepreneurship'. Most members of faculty were in favour of transfer activities but objected to the most radical forms of commercialisation such as start-up assistance to new technology firms, and equity investment by universities. In turn, other studies show that academic engagement tends to be viewed by academics as a natural extension of publication-driven 'open science', while commercialisation is seen as a distinct type of activity. Subscription to traditional scientific norms is not necessarily at odds with academic engagement (Boardman and Ponomariov, 2009) while a study of scientists at the Max Planck Society indicates that those believing that science is a public good are significantly less likely to pursue commercialisation (Krabel and Mueller, 2009).

The notion of engagement as complementary to traditional academic science is also supported by research on academics' underlying motivations. Lee (2000) found that science and engineering faculty at US research universities collaborate with private partners for two main reasons: (a) to access resources relevant to their research activities via additional funds, equipment and support for students, and (b) to access learning opportunities, such as field-testing opportunities for their own research and obtaining new insights. Similarly, a study of UK physical sciences and engineering faculty found that academic engagement was driven by research considerations (i.e. learning and resource access), while commercialisation was motivated by monetary incentives (D'Este and Perkmann, 2011).

On the organisational level, a noteworthy finding of our review is that academic engagement is negatively associated with organisation-level research quality in some studies and uncorrelated in other studies, in contrast to its positive association with high individual research quality and the commonly diagnosed positive relationship between engagement in commercialisation and university/department-level research quality. This means academic engagement is pursued by highly motivated and successful individuals who are, however, not necessarily affiliated to higher quality research institutions. One may hypothesise that academic engagement acts as a resource mobilisation device for high-performing individuals at lower ranked institutions, where fewer resources are available. Our results further suggest, that organisation-level support appears far more relevant for commercialisation activities than academic engagement, which tends to be driven by individuals and teams with little central support. Finally, on the institutional level, engagement is strongly associated with affiliation to engineering and applied sciences.

Synthesising our results, one may postulate three key insights for academic engagement. First, academic engagement is positively correlated with individual characteristics that define senior, scientifically productive individuals, indicating that it is in line with furthering their academic research activities. Second, engagement is less organisationally embedded than commercialisation activities, and is more autonomously driven by individuals. Third, engagement appears to be an effective tool for mobilising resources, and may function as a substitute for generous resource endowments at highly ranked institutions. One needs to exercise caution as the positive effects of engagement on scientific productivity are at this stage hypothetical, because the existing research is almost entirely based on cross-sectional analysis. The direction of causality is uncertain, therefore, leaving open the possibility that good research performance by individuals leads them to engage more. We will return to this issue in the discussion of methodological challenges.

The insights gained from the literature review are represented in a stylised model, outlining the various antecedents of academic engagement at the individual, organisational and institutional levels, as well as its consequences (Fig. 2). We also highlight the factors – indicated by dashed lines – that require more research either because they were relatively neglected by previous research or because studies yielded conflicting or ambiguous results.

### 5.2. Implications for conducting research

Our conceptual considerations and review of the literature suggest that the study of academic engagement requires distinct analytical and methodological approaches. Analytically, given that academic engagement means collaboration, approaches focused on studies of how individuals within organisations initiate, build and

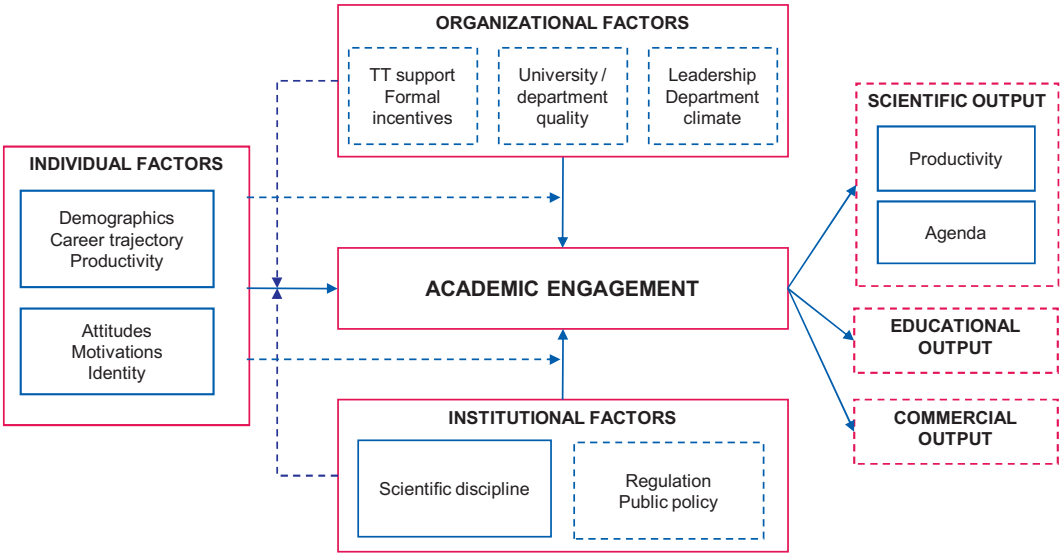


**Fig. 2.** An analytical framework of external engagement by academic researchers.

maintain collaborations with other organisations (e.g. firms) are relevant for studying it (Bouty, 2000; Kreiner and Schultz, 1993). Hence aspects such as the motivation for individuals to engage in collaboration, the formal characteristics of the collaboration, and outcomes both at individual and organisational levels are salient. Specifically, in terms of motivation, collaboration may be pursued for a variety of reasons, such as attracting resources, obtaining knowledge, or building social capital. Commercialisation, by contrast, implies a more narrowly focused interest in the exploitation of a specific technology. Hence, analytically, commercialisation is more akin to an entrepreneurial act or at least, in the case of patenting, a first step towards it. Researchers have therefore used the language and analytical framework of entrepreneurship to explore commercialisation, involving an emphasis on the aspects of opportunity recognition and individual economic incentives (Lach and Schankerman, 2008; Shane, 2004; Wright et al., 2007).

Empirically, academic engagement leaves distinct traces. For instance, academic entrepreneurship can be measured by counts of university spin-offs or company directorships maintained by academic researchers. Information on patents is accessible via public patent directories; various studies have successfully attempted to identify university-invented patents that are not assigned to universities, in addition to patents assigned to universities (Lissoni et al., 2008; Thursby et al., 2007). Even though more widely practiced, academic engagement is empirically more difficult to detect because it includes collaboration instances that may not be documented by generally accessible records. Researchers have approximated engagement via instances of co-authorship between university researchers and industry scientists (Liebeskind et al., 1996; Murray and Stern, 2007). This procedure however is likely to under-represent collaborations that are more applied in nature and do not result in publications, such as contract research or consulting assignments. Records held by universities on industry contracts would represent an ideal source of information but are not readily available because they are often considered commercially sensitive by university administrators, in addition to which such records are likely to underestimate consulting activities. Moreover, they are difficult to standardise across large numbers of universities. Nevertheless, studies using record-based information for single universities or a small number of institutions can offer powerful insights with a high level of granularity (Rawlings and McFarland, 2011).

In facing the above challenges, the overarching majority of studies have traced such engagement by asking academics for self-reported information, usually via questionnaires. Questions tend to be structured around the essential characteristics of collaboration instances, such as underlying motives, resources exchanged and the type of collaborative arrangements. It is clear that relying on self-reported information is fraught with specific challenges which future work should address in order to improve the quality, reliability and validity of research results.

A first issue regards the lack of longitudinal data. In fact, all large-scale survey-based studies are based on cross-sectional data and therefore pose limitations in terms of inferring causal relationships between variables. For instance, it is unclear whether individual research performance is enhanced by academic engagement, or engagement is a mere consequence of high research performance. On the basis of existing evidence it is difficult to say whether engagement in one period is linked to activities in a prior period. While a new generation of studies using panel data on academic patents and publications has taken into account the time dimension (Stuart and Ding, 2006), this has yet to be accomplished by research using survey data, the main source of information on academic engagement. The only studies acknowledging the longitudinal dimension are qualitative contributions (Etzkowitz, 1998; Jain et al., 2009; Kenney and Goe, 2004; Shinn and Lamy, 2006). Future research should conduct surveys repeatedly, or at least administer subsequent surveys containing some identical questions, across a comparable population of academic researchers.

Second, the validity and comparability of results are hampered by the way measures are constructed. Across the studies we examined, the measures for the key dependent variable (i.e. academic engagement) varied considerably. While most authors capture the frequency of engagement, others measure the 'importance' of specific channels perceived by individuals. The latter is more problematic because individuals vary in how they define importance. Approaches that measure the frequency of engagement, possibly going beyond yes/no statements and accounting for the number of engagements over a period of time, are preferable because they are more likely to reflect facts. The use of different measures also impedes comparisons across studies. Bozeman and Gaughan (2007) proposed an index that takes into account not only the variety of interaction mechanisms, but also their "difficulty" or "rareness". This index could provide the starting point for a harmonisation of efforts across different studies.

Similar considerations apply to measuring other variables, such as motivation, organisational conditions or outputs resulting from academics' external engagement. Items not well grounded in theory may produce meaningless or even misleading results, and hence hamper comparison between different datasets. Here researchers should use well-established scales, like those found in motivation research, or combine surveys with field studies to thoroughly understand the phenomenon (Bearden and Netemeyer, 1999). Some studies also fail to differentiate between the measurement of perceptions and structural factors. For instance, while some surveys simply measure academics' perception of organisational support for engagement activities, others attempt to capture structural features by requesting fact-derived information. The latter approach is preferable because it reduces social desirability bias (Podsakoff et al., 2003) as respondents may believe that it is socially desirable to be 'entrepreneurial' and engage with industry.

Reaching a consensus on the central measures relating to academic engagement, such as activities, motivations, barriers and outcomes, would improve the quality and comparability of studies. Researchers should therefore disclose the scale items they use as well as scale means, individual item means and standard deviations across different groups, providing a frame of reference for potential scale users (Bearden and Netemeyer, 1999).

Finally, existing studies are afflicted by incoherence in the populations studied, raising questions over the external and internal validity of results. Ideally, sampling procedures should ensure population representativeness and avoid sampling bias. Many studies focus on specific disciplines whilst others address populations of academics at particular universities, possibly representing the outcome of convenience sampling that risks skewing results. Future research should ensure population representativeness and also limit selection bias. For instance, the disciplinary scope of the surveyed population could be enlarged, and more universities could be targeted. The central practical challenge for researchers – successfully addressed by some studies (Abreu et al., 2009) – is to generate large lists of researchers that are either reflective of the whole population, or a random non-biased sample. Some of our suggestions will be more costly to implement than others. Yet, designing appropriate measures and factual questions do not come with increased cost, so researchers should start here. Similarly, response bias may be detected and remedied with the appropriate statistical methods.

We provide an overview of the sampling techniques we encountered in the literature in Table 4, summarising their advantages and disadvantages.

The existence of a reliable and both nationally and internationally comparable evidence-base on academic engagement would serve as a valuable resource for policy-makers. In the UK, Sweden, Spain and Italy, for instance, data on academic engagement is, at the time of writing, collected nationally but only for universities in aggregate,[1] and not for individuals. Efforts to standardise measures and ensure individual-level data collection exercises encompass larger populations of universities would allow policy-makers to reach better judgements of the strengths and weaknesses of types of collaboration, profiles of individuals, organisational specialism and universities. It appears that research funding bodies are best positioned to sponsor or even carry out data collection, as the resource dependence of academic researchers makes them more likely to respond to requests extended by these kinds of organisations.

[1] See: the HEBCI (Higher Education Business and Community Interaction) Survey in the UK (http://www.hefce.ac.uk/econsoc/buscom/hebci), Statistics Sweden (http://www.scb.se/Pages/Product_8793.aspx), RedOTRI in Spain (http://www.redotriuniversidades.net) and ANVUR in Italy (http://www.anvur.org).

### 5.3. Agenda for future research

Our analysis of the literature has not only generated novel insights into the nature of academic engagement but also indicates areas that require further research. First, while the individual-level determinants are relatively well explored, more research is needed on the organisational context in which industry engagement occurs and how it moderates individual characteristics. Our finding that traditional technology transfer infrastructures play a lesser role in facilitating academic engagement does not necessarily imply that other organisational characteristics may not be instrumental. Rather than centralised support mechanisms, characteristics of the department or the research teams in which academics operate, may be more salient in determining engagement. Research should explore aspects of organisational ambidexterity, i.e. whether engagement is associated with a diversification of skills, roles, and organisational units adept at dealing with academic and industrial requirements. In other words, studies should investigate whether the structure and profile of research teams and departments explains engagement with industry, rather than the individual-level variables that are commonly perceived as critical. This kind of analysis would also enable us to substantiate the above claimed link between engagement and resource mobilisation, given organisational contexts vary significantly in terms of resource munificence. Furthermore, for organisation-level factors, extant research has focused on technology transfer or licensing offices while the role of organisational support in the guise of industrial liaison offices or business relationship offices has been disregarded. Future research should take these structures into account when analysing engagement, with the possible outcome that organisation-level (i.e. university-wide) variables may play a more important role than hitherto thought.

Second, the consequences and impacts of academic engagement need to be further explored. Extant analyses have neglected to consider its impact on educational outputs, such as time devoted to teaching, curriculum and courses development, and teaching quality. Insights into this aspect of engagement would be highly valuable in extending our knowledge of the benefits or costs of 'third stream' activities within the context of universities' other missions.

Third, future research should explore the relationship between academic engagement and commercialisation. Whilst our comparison suggests that both types of activities may be driven by different underlying mechanisms, we cannot infer possible complementarities or contradictions between them. Research here should address two issues. On the one hand, there may be a temporal relationship between engagement and commercialisation, in the sense that prior involvement in collaboration with industry may lead to commercial output later in time, either individually or within research groups. On the other hand, researchers should investigate the possibility that some types of collaboration are complementary with commercialisation outputs while others may be neutral or even compete with them. Knowing more about the relationship between academic engagement and commercialisation would also benefit policy debates by clarifying whether the policies designed to stimulate entrepreneurship also stimulate academic engagement, or whether more focused approaches are needed.

Fourth, institutional aspects should be further investigated. Most studies focus on the United States and selected European countries while contributions covering other geographic contexts are rare (Giuliani et al., 2010; Walsh et al., 2008). Furthermore, few studies offer cross-national comparative analyses (Dutrenit and Arza, 2010; Grimpe and Fier, 2010; Haeussler and Colyvas, 2011; Klofsten and Jones-Evans, 2000). The context-specific nature of most published research makes it difficult to form generalised conclusions. It seems plausible that countries with different higher

**Table 4**
Sampling techniques.

| Type of sampling | Implementation | Benefits | Drawbacks |
|---|---|---|---|
| Census (whole academic population) | Official list of academics (i.e. from the Ministry of Education) | No bias towards a single university or discipline | Resource intensive |
| | Manual search on universities' website | Completeness | Official lists only available in some countries (i.e. where academics are civil servants) |
| Selected universities | List of academics from the university central administration office | No bias towards a single discipline | Organisation bias |
| | Manual search on universities' website | | Large institutions tend to be preferred |
| Selected disciplines | List of academics located in specific departments from the university central administration office | No bias towards a single university | Discipline bias |
| | Manual search on universities' website | | Definition of scientific disciplines can be ambiguous |
| Selected groups (i.e. grant holders) | List of academics from the organisation which defines the group (i.e. the organisation awarding the grants) | Relatively cheaper | Group biased |
| | | No bias towards a single university | Possibly discipline biased |

education and public science systems, different stages of economical development and different innovation systems will exhibit different patterns of university–industry relations, and different antecedents and consequences. For instance, the regulations concerning intellectual property ownership for university-generated knowledge vary between countries. These and other differences are likely to systematically shape academics' response to external factors, as well as the outcomes of academic engagement. Future research should therefore seek to cover multinational settings, ideally by deploying harmonised survey tools. The tools currently available, such as university-level indicators on TTO activity, are too coarse for meaningful international comparison, so micro-measures of engagement will provide superior information.

Fifth, as most research hitherto on academic engagement is phenomenon-driven, future research should deploy data on this phenomenon to build and test theory. For instance, studies may view academic engagement as pro-active behaviour in knowledge-intensive organisations (Crant, 2000). Academia is an ideal context to study this kind of individual behaviour – likely to be beneficial to overall organisational performance – because academics enjoy a large degree of professional autonomy, and hence their individual performance as well as their contribution to organisational goods is driven largely by self-motivation rather than command and control. Moreover, relative to professional service organisations, academic settings are richer in publicly available data on individual characteristics such as performance and career histories, enabling more detailed studies. Another opportunity for contributing to theory may arise from studying how individuals respond to local norms, such as those prevailing in their immediate, departmental work contexts (Bercovitz and Feldman, 2008), and how these relate to global norms for instance at the level of scientific disciplines (Fini and Lacetera, 2010). This may also provide clues for determining the locus of possible policy interventions aimed at supporting engagement or mitigating adverse effects. Finally, within institutional theory, academic engagement may offer insights into how individuals within organisations manage exposure to different logics (Friedland and Alford, 1991), that of academic science and of commercial R&D (Murray, 2010). Working with industry is likely to generate conflicting pressures including whether research results should be public or private, and whether research should be oriented towards publication or technical application (David, 2004). Although we know that ambidextrous management of both logics is commonplace, the study of academic engagement is likely to expand our understanding of how individuals accomplish this and what factors enables these efforts.

## 6. Conclusions and policy implications

Exploring external engagement by academic researchers is of undoubted interest to practitioner audiences, notably policy-makers and university managers. Government agencies and universities themselves have made concerted efforts to increase academic engagement, for reasons ranging from generating societal legitimacy for publicly subsidised scientific research, stimulating economic activity to raising revenue for universities. There are three policy-related lessons that can be drawn from our review.

First, our analysis suggests a partial lack of understanding about the consequences of academic engagement. Evidence on the impact of these collaborations on other university activities, such as research and teaching, is scarce so it cannot be assumed that engagement activities are always beneficial and should therefore be promoted. Further research on the consequences of engagement will allow policy-makers to derive considered judgements as to what behaviours and organisational forms to promote, and under which conditions they are likely to further scientific and/or economic objectives. For instance, a better grasp of the causal relationship between engagement and research performance is crucial for designing policy interventions. If engagement spurs research performance, it is obvious that engagement should be promoted if policy-makers wished to promote better research. However, if the opposite is true – research performance drives engagement – interventions would need to promote research excellence leading to further engagement. This issue is particularly salient in the context of increasing pressures exerted by democratic constituencies to evaluate the impact of academic research. As funding bodies in many countries require bidding academics to provide evidence of societal impact (and not just on the academic community), understanding how engagement results in such benefits, and simultaneously maintain scientific quality, appears now of greater relevance.

Second, research on university–industry interaction has strongly emphasised the role of TTOs or liaison offices, so some

policy-makers have consequently resorted to subsidising technology transfer operations at universities. This instituted an organisational focus at universities on formal mechanisms of commercialisation, i.e. patenting, licensing and entrepreneurship. As our review suggests, these technology transfer structures are less adept at fostering academic engagement. From a policy perspective, it is important to recognise that different transfer or collaboration mechanisms may require different support structures and incentive mechanisms. As individual discretion seems the main determinant of academic engagement with industry, policy measures should address individuals, in addition to influencing university practices and structures. For instance, fostering individual-level engagement skills would appear to be a potentially powerful lever, not only for increasing the volume of university–industry relations but also their quality. In this respect, policy should not implicitly assume that 'more is better' but seek to differentiate the conditions under which engagement generates both academic and industrial benefits, so minimise the risk of failure.

Third, considering the higher volume of engagement activities than patenting and entrepreneurship, it is essential that firms be well-equipped to effectively participate in collaboration (Perkmann and Salter, 2012). If policy aims to successfully increase the impact of academic research through fostering engagement, not only academics but firms too need to be skilled in initiating and maintaining such collaborations, crucially recognising that collaborating with academia presents distinct challenges, separate to those of customers or suppliers. Particularly when collaborating with the best academic researchers, firms need to take into account that these academics will under most circumstances only work with them if there is *also* some academic benefit to be derived. In order to reduce transaction costs, policy-makers should additionally seek to establish some guidelines or standard contracts to guide both partners during the negotiations, such as those of the 'Lambert agreements' in the UK or the arrangement between Procter & Gamble and the University System of Ohio (Lambert, 2003).

A final issue relates to the theoretical underpinning implied in much of the current research. Studies commonly conceive academic science as a discrete institutional order that differs from industry on the basis of academic values, norms and conventions as laid out by Mertonian sociology of science (Merton, 1973). Even if such a discrete, binary characterisation may be analytically appropriate in some instances, it may underestimate the diversity of organisations and institutional orders found within the international higher education and public R&D sectors. The archetype of the research-intensive university represents, in fact, only one type of organisation within a field populated by entities as diverse as professionally oriented polytechnics, national R&D laboratories and liberal arts colleges. A considerably proportion of academics do not conduct research, or at least not research close to the frontiers of knowledge production. It is important, therefore, to differentiate the 'frontier researchers' and their external engagement, from those who are removed from it when conducting their research. Furthermore, differences in how universities are governed and managed across different countries may be important in determining individuals' engagement with non-academic organisations.

An important objective for future research is, therefore, to question the pervasiveness and purity of Mertonian norms, and shed light on the differences characterising the diverse patterns of university-society interactions in various settings. If organisational or even group-level variance is more important than previously thought, a view supported by recent studies using data on patenting or disclosures data (Bercovitz and Feldman, 2008; Stuart and Ding, 2006), then relaxing the assumption of relative homogeneity across the organisational population becomes a crucial aspiration for research in this area.

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## Appendix A.

Keyword: combinations used for literature search:

"joint research" and "university*/academi*/facult*" and "industry*"
"collaborative research" and "university*/academi*/facult*" and "industry*"
"contract research" and "university*/academi*/facult*" and "industry*"
"technology transfer" and "university*/academi*/facult*" and "industry*"
"commercialize" and "university*/academi*/facult*" and "industry*"
"academic entrepreneurship"
"university–industry"

## Appendix B.

Articles analysed.

| Article | Research questions | Data | Method | Dep. variables | Findings |
|---|---|---|---|---|---|
| Azagra-Caro et al. (2006) | (1) What determines individual support for university–industry interactions? (2) Are there differences between technology-leading countries and in regions with low absorptive capacity? | Questionnaires sent to random sample (10%) of faculty at five public universities in the Valencian Community (Spain). Response rate 44%. | Regression | (1) Support for different objectives of university–industry relations (orientation, development, commercialisation, firms, funds, teaching); (2) Perceived degree of R&D cooperation with firms | (1) University's age is negatively related to faculty's support of UIR objectives; (2) Disciplinary effects and university support are not significant in shaping faculty's support of UIR objectives; (3) Faculty's support to UIR activities is hindered by the fear of losing academic freedom; (4) The results are obtained in a region with low absorptive capability |
| Azagra-Caro (2007) | What type of faculty member interacts with what type of firm? | Survey to 380 academic researchers in the five universities of the Valencian Community. Response rate 44%. | Regression | (1) Contracts with firms; (2) size of collaborating firms; (3) geographical location of the firms; (4) technological level of collaborators; (5) educational qualification of collaborators | Only selected types of faculty members interact with specific types of firms: some faculty members will show higher propensity to engage into UII (those in specific scientific areas, who have more resources for R&D activities, with a senior status, male and holding an administrative position) and at least some of them (those who have more resources for R&D activities, male and holding an administrative position) will find it easier to interact with some firms (those of larger size, in science-based sectors). |
| Bekkers and Bodas Freitas (2008) | What explains the importance of different knowledge transfer channels used by academics? | Two related questionnaires, one aimed at 2082 university researchers and one at 2088 industry researchers. For universities: All research staff of five Dutch universities in the faculties of pharmaceutics and biotech, chemistry, mechanical engineering and electrical engineering. 575 completed questionnaires, 27.6% response rate. For industry: Similar procedure (they are all inventors). Response rate 26%. | Regression | Six groups of channels for knowledge transfer: (1) scientific output, informal contacts and students; (2) labour mobility); (3) collaborative and contract research; (4) contacts via alumni or professional organisation; (5) specific organised activities; (6) patents and licensing | Differences in importance of various channels of KT can be explained by: (1) Basic characteristics of the knowledge in question (tacitness, systemicness, expected breakthroughs); (2) The disciplinary origin of the knowledge involved (as opposed to the sectoral activities of the partner firms); (3) To a lesser degree individual and organisational characteristics (seniority, publication record, patent record, entrepreneurship, research environment). |
| Barbolla and Corredera (2009) | What underpins success in research contracts from the standpoint of individual academics? | Interviews with 30 academics at the Technical University of Madrid | Qualitative | (1) Project features; (2) company involvement; (3) core competency and motivation of the university; (4) relationship among players | Creation of a model for technology transfer. Three characteristics of a partner company influence the result of a particular collaboration with the university: (1) the corporate perception of usefulness of the project; (2) the capacity of the company to integrate the results in its value chain; and (3) the company's confidence in the university team. |
| Bird and Allen (1989) | How does faculty perceive and respond to entrepreneurial and commercialisation opportunities? | Mail survey to 767 faculty members at University of North Carolina and North Carolina State University who received an external grant or contract in the previous three years. Response rate 25%. | Descriptive | (1) Past contacts with clients or parties arising from research and consulting activities; (2) academics' future research, consulting and commercialisation plans | (1) 71.3% of faculty are involved in consulting while 7.6% are involved in commercialisation. Most faculty do not expect to alter their relationship with the university as a result of the commercialisation potential of their research. |
| Blumenthal et al. (1996) | What are the effects of university–industry relationships on academics? | Questionnaire mailed to 3169 academics in the life sciences at the 50 US universities receiving the most research funding from the NIH. Response rate 65%. | Regression | (1) Academic activities; (2) Commercial activities; (3) Restriction of communication; (4) Choice of research | (1) Faculty members with industrial research support are at least as productive academically as those without such support and are more productive commercially; (2) Faculty members with relationships with industry are more likely to restrict their communication with colleagues. |

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| Boardman (2008) | What is the impact of affiliation with university biotechnology centres on the industrial involvement of university scientists? | National survey of 4916 academic researchers, conducted by Research Value Mapping Program at Georgia Tech. Tenured and tenure-track university researchers employed in doctorate granting research extensive institutions. Sample stratified by academic discipline, academic rank and gender. Response rate 38%. | Regression | Mode of engagement with industry during the 12 months preceding survey (consultancy, student placements, worked in a company, patent/copyright with industrial partner, commercialisation of research, co-authored paper with industrial researchers)–binary variables combined into an indicator of industrial involvement | University biotech centre affiliation correlates positively with industry involvement in terms of informal interactions, but not with economic and bibliometric outputs. |
| Boardman and Corley (2008) | What is the impact of affiliation with a university research centre on university scientists' collaborative behaviours? | Survey of 4916 US academic researchers, conducted by Research Value Mapping Program at Georgia Tech. Tenured and tenure-track university researchers employed in doctorate granting research extensive institutions. Response rate 38%. | Regression | Percentages of research work time spent in seven collaboration settings (alone, immediate group, home university, other nations, other universities, industry, government labs) | (1) Centre affiliation is negatively correlated with time spent working alone in research; (2) Centre affiliation is positively correlated with collaboration outside the immediate work group but within the university; (3) Centre affiliation is negatively correlated with collaboration with other US universities; (4) Industry collaboration is positively correlated with industry-linked centre affiliation. |
| Boardman and Ponomariov (2009) | Which individual characteristics explain academics' involvement with industry? | Survey of 4916 US academics at research universities, conducted by Research Value Mapping Program at Georgia Tech. Response rate 38%. | Regression | (1) Respondents' interactions with the private sector during the previous 12 months; (2) Modes of interaction (formal contact, informal contact, consulting, placing students, owner/employee of a private firm, patenting and/or copyrighting, transferring and commercialising technology, co-authoring papers). | (1) Positive relationship between conducting government-funded research and supporting graduate students and interactions with the private sector; (2) Subscription to traditional scientific norms is not necessarily at odds with pursuing commercially relevant activities; (3) Scientists affiliated with university research centres are more likely to interact with the private sector |
| Boardman (2009) | How different types of university research centres affect individual level U-I interactions? | National survey of 4916 academic researchers, conducted by the Research Value Mapping Program at Georgia Tech. Tenured and tenure-track university researchers employed in doctorate granting research extensive institutions. Sample stratified by academic discipline, academic rank and gender. Response rate 38%. | Regression | Industry involvement | Affiliation with an industry-related centre correlates positively with the likelihood of an academic researcher having had any research-related interactions with private companies, while affiliation with centres sponsored by government centres programmes correlates positively with the level of industry involvement, no matter whether these centres additionally have ties to private companies. |
| Bozeman and Gaughan (2007) | What is the impact of research grants on academics' involvement with industry? | Survey of 4916 US academic researchers, conducted by Research Value Mapping Program at Georgia Tech. Tenured and tenure-track university researchers employed in doctorate granting research extensive institutions. Sample stratified by academic discipline, academic rank and gender. Response rate 38%. | Regression | Industrial activity, measured via industrial involvement scale (synthetic index) | (1) Academic researchers who have research grants and contracts work more extensively with industry; (2) Scientists with industry contracts interact with industry more than those who are exclusively government funded. |
| Campbell and Slaughter (1999) | (1) Do faculty and university administrators hold different views on IP and related topics? (2) Are the views of academics not collaborating with industry different? | Survey of representatives of 12 largest public universities in each of the Carnegie classifications. Included individuals from science and engineering, social sciences, fine arts, and business. Response rate 34%. | Descriptive | (1) Conflict of interest (IP, entrepreneurship; (2) Conflict of commitment; (3) Conflict over internal equity | (1) Faculty and administrators hold different views, particularly on issues related to control over relationships with industry. Faculty favors ways to retain autonomy, while administrators seek ways to control faculty's participations in UIRs; (2) Involved faculty are more enthusiastic about engaging in revenue-generating opportunities than non-involved faculty; (3) Non-involved faculty support collaboration with industry but are less supportive of the specific repercussions that might arise from these relationships |

| Article | Research questions | Data | Method | Dep. variables | Findings |
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| D'Este and Perkmann (2011) | What are the motivations for academics to engage with industry? | Survey of 4337 university researchers in the UK (principal investigators with EPSRC grants). Response rate 35%. | Regression | Frequency of interaction with industry using different modes of interaction | Most academics engage with industry to further their research rather than to commercialise their knowledge. Joint research, contract research and consulting are strongly informed by research-related motives. |
| D'Este and Patel (2007) | (1) What are the channels through which academic researchers interact with industry? (2) What explains the variety of interaction? | Survey of 4337 university researchers in the UK (principal investigators with EPSRC grants in the period 1995–2003). Response rate 35%. | Regression | (1) Interaction channels used by individual researcher; (2) Number of interaction channels through which a researcher has engaged more frequently than the average | (1) University researchers interact with industry using a variety of channels; (2) Individual characteristics (previous experience, academic status) have a stronger impact than the departmental or university characteristics in explaining the variety of interaction between academics and industry |
| Giuliani et al. (2010) | (1) What is the role of researchers' individual characteristics in explaining their propensity to engage with industry? (2) What is the role of researchers' institutional environments in explaining their propensity to engage with industry? | Survey to 135 academic and PRO's researchers in the wine field in Chile, South Africa and Italy | Regression/ Network analysis | (1) Normalised degree of centrality of each researcher's U-I network | The centrality of researchers in the national research system is highly significant. Researchers' demographic characteristics, such as age and sex, are related to the propensity for researchers to form U-I linkages, whereas educational background, academic status and publication performance do not seem to influence this relationship. Working in a university vis-à-vis another type of public research organisation produces a higher propensity to engage with industry but the characteristics of the research organisations where researchers work appear to influence U-I linkages to a lesser extent. |
| Grimpe and Fier (2010) | What are the effects of institutional differences on the choice of scientists to transfer technology informally? | Survey to 16,296 German university scientists (17.2% response rate). Same questions as the Research Value Mapping Program. | Regression | (1) Commercialisation; (2) joint publication; (3) consultancy | (1) Confirmation of Link et al. (2007) results; (2) Being a research group leader increases commercialisation and consulting; (3) Almost no effect of scientific productivity on informal TT; (4) Positive impact of previous patents on all forms of TT |
| Gulbrandsen and Smeby (2005) | What does industry funding affect research performance? | Questionnaire sent to all faculty members of the rank of assistant professor or higher at Norway's four universities. Response rate 60%. | Regression | (1) Patents; (2) Commercial products; (3) Establishment of firms; (4) Consulting contracts | Professors with industrial funding: (1) perform more applied research; (2) collaborate more with other researchers both in academia and in industry; (3) report more scientific publications and entrepreneurial outputs |
| Haeussler and Colyvas (2011) | Does engagement in academic entrepreneurship reproduce the existing social structure of science? | Questionnaire (2007) to 2294 German and UK university life scientists who either published or patented between 2002 and 2005 (between 17% and 26% response rate). | Regression | (1) Consulting with companies; (2) applied for at least one patent; (3) have founded a company; (4) commercial activity index (combination of the previous three) | Characteristics reflecting professional security, advantage and productivity are strong predictors for a greater breadth of participation in academic entrepreneurship, but not for all forms of technology transfer. Scientists perceive the value of patenting differently, and the level of reputational importance placed on scientific compared to commercial achievements matters in shaping commercial involvement. |
| Klofsten and Jones-Evans (2000) | How do academics engage with industry? | Questionnaire mailed to 5020 academics in the faculties of science, engineering and medicine in five Irish universities four Swedish universities. Response rate 37%. | Descriptive | Activities including contract research, consulting, large scale science projects, external teaching, testing, patenting/licensing, spin-off, sales | (1) Low engagement activities of female and junior faculty; (2) High degrees of involvement in 'soft' activities such as consultancy and contract research, but not in creation of technology spin-offs; (3) Irish and Swedish present comparable level of entrepreneurship even if Swedish policies are more sophisticated. |
| Lam (2010) | How is the shifting boundary between university and industry experienced by academic scientists? | 36 in-depth individual interviews and a survey to 734 academic scientists from 5 UK research universities | Qualitative | Type of academic | There are four possible orientations: two polar types ('traditional' and 'entrepreneurial') and two mixed types ('traditional hybrid' and 'entrepreneurial hybrid').The hybrids are the dominant category and are particularly adept at exploiting the ambiguities of boundary work between academia and industry. |
| Lee (1996) | What does faculty think about university involvement with industry? | Mailed survey questionnaire and field interviews with university officials responsible for university–industry relations. The survey data is supplemented by two other sources: the National Science Foundation's 1994 Academic Science and Engineering R&D expenditure data; and Feller and Geiger's university ranking. Questionnaire sent to 2292 academic researchers in various disciplines at 194 US research universities. Response rate 43%. | Regression | Faculty transfer attitudes towards technology transfer | (1) US academics in the 1990s are much more favourably disposed than in the 1980s towards policies supporting knowledge transfer from universities (2) Faculty members are reluctant to support policy designed to 'privatise' academic research; (3) The fear of possible negative consequences hinder the collaboration between academia an industry; (4) Faculty in applied disciplines is more supportive of knowledge transfer |

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| Lee (1998) | (1) What role do academics believe that they and their university should play in university collaboration? (2) What are the factors that influence their attitudes and perceptions? | Equivalent to Lee (1996) | Regression (structural equations) | Faculty transfer attitudes towards technology transfer | (1) Academics are generally in favour of close UI collaboration on TT, especially if this is tied to regional economic development rather than firms' profits; (2) Faculty perceive a tension between the need of industry finding for academic research and the need to preserve academic freedom; (3) Policy-makers should take into consideration the pressure arising when the marginal opportunity cost associated with firm-specific research exceeds the marginal benefits of the collaboration. |
| Lee (2000) | (1) What are the motivations of academic scientists for collaborating with industry? (2) What are the benefits academics get from collaboration? | Questionnaire mailed to 671 university faculty members from 40 US research-intensive universities in the departments of biological science, chemistry, chemical engineering, computer science, mechanical engineering, and material science; 64% response rate. Questionnaire to 306 affiliate members of the University Technology Managers Association. Response rate 50%. | Descriptive | (1) Motivations for collaboration (academics and industry); (2) Benefits derived from collaboration (academics and industry) | (1) Academics seek collaboration with industry to secure funds for their graduate students and lab equipment, supplement their own research, field-test the application of their own research, and gain new insights; (2) Faculty members benefit from collaboration with industry by acquiring funds, gaining valuable insight and field-testing the practical application of their research. |
| Lin and Bozeman (2006) | What is the impact of researchers' previous industry experience on their academic productivity? | Curriculum Vitae (CV) database containing demographic information, educational background, employment record, publication data, patent data, professional affiliations, and grant/funding information. Survey of Careers of Scientists and Engineers sent to the 997 fulltime academic faculty and postdoctoral researchers in the CV database. Response rate 44%. | Regression | (1) Publication productivity; (2) Number of students supported | (1) Academics with prior industry exposure produce fewer total career publications, but they support more students; (2) Previous industry experience raises the annual publication productivity of junior faculty members and women researchers. |
| Link et al. (2007) | What determines informal technology transfer activities by university faculty? | Survey of 4916 US academic researchers, conducted by Research Value Mapping Program at Georgia Tech. Tenured and tenure-track university researchers employed in doctorate granting research extensive institutions. Sample stratified by academic discipline, academic rank and gender. Response rate 38%. | Regression | Informal technology transfer (involvement in activity to transfer or commercialise technology, involvement in joint publications, consulting) | (1) Male faculty members are more likely than female faculty members to engage in informal commercial knowledge transfer and consulting; (2) Tenured faculty members are more likely to engage in informal technology transfer; (3) Faculty members who allocate a higher percentage of their time to grants-related research are more likely to engage in informal technology transfer. |
| Louis et al. (2001) | Are there any differences in entrepreneurial behaviour between clinical and non-clinical faculty? | Questionnaire to 4000 clinical and non-clinical faculty in life-science departments in the US. Response rate 64%. 847 questionnaires used. | Regression | (1) Secrecy (being denied access to research results, had denied access to research results); (2) Productivity (research, teaching, service); (3) Research budget | (1) Clinical faculty is more dependent on industry funding; (2) Non-clinical faculty is personally involved in the commercialisation of their research and more likely to experience data withholding. |
| Louis et al. (1989) | What are the factors that explain different form of academic entrepreneurship? | Two surveys, one to 1594 life scientists in major universities, one to 40 university administrators in the same universities. Response rate 69%. | Regression | Forms of academic entrepreneurship: (1) large-scale science; (2) supplemental income; (3) additional research funds; (4) patenting results of academic research; (5) forming companies | (1) Life scientists in research-intensive universities are modestly entrepreneurial; (2) Scientifically productive researchers are more entrepreneurial, this relationship is weaker for more commercial forms of engagement; (3) scientists concerned about protecting science from pressures to commercialise are less likely to be entrepreneurial |

| Article | Research questions | Data | Method | Dep. variables | Findings |
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| Martinelli et al. (2008) | Map Sussex University's external relations and to uncover its knowledge exchanges and its UITT network | Questionnaire to 710 Sussex University faculty members (asking names of partner organisations and type of collaboration). Response 24%. | Descriptive | (1) Types of knowledge exchange (transmission, presentation, effort, consultation, use, business activities, commercialisation); (2) Types of external links (patents, consultancy, collaborative research, research contract, research grant, research students, KTS); (3) nature of partners (biomed, traditional, ITSIS, technology, media, telecom, government); (4) entrepreneurial culture; (5) IP awareness | In spite of a comparatively late start, a considerable number of researchers engage in knowledge exchange processes with industry and other non-academic partners. Faculty in the social sciences and humanities as well as natural sciences and engineering maintain links to industrial partners, including multinational corporations. Schools differ in the way their faculty engage in university–industry collaborations. Further differences can be observed with respect to faculty attitudes towards technology transfer and awareness of the university's respective codes of practice |
| Nilsson et al. (2010) | (1) Why do researchers engage in commercialisation at all? (2) If researchers do transfer research, how do they choose to perform that transfer? | Seven longitudinal case studies in three Swedish research centres performing research on stem cells | Qualitative | (1) Determinants of choice (perceived role of the univ., supportive infrastructure, industrial actor set-up, networks); (2) mechanisms of transfer (pubs and conferences, patents and licenses, spin-offs, sponsored research, informal discussion, shared personnel, labour movement) | (1) The organisational, regulatory and working environment encourages engagement in TT; (2) Researchers engage in TT because they want to secure funding for their research, put their research into practical use, gain private financial benefits; (3) Researchers use the TTO if they believe it is competent or if they do not have enough social capital themselves, otherwise they interact directly with firms |
| Ponomariov (2008) | Which university characteristics influence the propensity of individual scientists to interact with industry? | Survey of 4916 US academics in doctorate granting, research extensive institutions researchers, conducted by Research Value Mapping Program at Georgia Tech. Response rate 38%. | Regression | (1) Industrial involvement scale (Bozeman and Gaughan, 2007); (2) additive scale of different types of interaction; (3) engagement with industry (binary); (4) quintile of distribution of industrial involvement scale for each individual (ordinal) | (1) The propensity of scientists to interact with the private sector is positively affected by income from industrial R&D; (2) The propensity of scientists to interact with private sector is negatively affected by the average academic quality. |
| Ponomariov and Boardman (2008) | Do informal interactions between university and industry scientists result in collaborative research? | Survey of 4916 US academic researchers, conducted by Research Value Mapping Program at Georgia Tech. Tenured and tenure-track university researchers employed in doctorate granting research extensive institutions. Sample stratified by academic discipline, academic rank and gender. Response rate 37%. | Regression | Percentage of research time devoted to working with researchers in industry | University scientists involved in informal interactions with industry are more likely to engage in collaborative research and are more likely to spend larger proportion of their research time working with researchers in private firms. |
| Renault (2006) | Why do professors seek intellectual property protection for the results of their research? | Survey of 420 faculty members in 12 research-intensive US universities (14% response rate). 39 face-to-face interviews with faculty. Interviews with TTO and incubators administrators. Additional data from AUTM and NSF. | Regression | (1) Collaboration (dummy); (2) Patent filed (or intention to file); (3) Spin-off involvement (or intention to spin-off) | (1) The norm of academic capitalism is not universally embraced; (2) A positive individual attitude towards academic capitalism increases the likelihood of participation in collaboration with industry and commercialisation of research; (3) Technology transfer participation is positively affected by academic quality and technology transfer policies |

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| Van Dierdonck et al. (1990) | What explains the attitudes of academics towards university–industry technology transfer? | Questionnaire to 300 heads of laboratories at 13 Belgian universities in four disciplines: sciences, medicine, engineering and agriculture. 77% response rate. Structured interviews with 8 Technology transfer office members. Questionnaire to 137 companies in university science parks. Response rate 50%. | Descriptive | Collaboration activities | (1) Experience with industrial collaborations positively affects the attitude of the academic researcher towards industry; (2) Personal efforts of the academic researcher in creating collaboration opportunities for his laboratory are more important than institutionalised transfer mechanisms. |
| van Rijnsoever et al., 2008 | What influences the intensity of the interactions between university researchers and their academic and industrial partners? | Questionnaire to all the scientific employees of Utrecht University. 17% response rate. | Network analysis | (1) Network activity (degree to which the researchers use their contacts for research purposes); (2) Academic rank | (1) Networking with academic researchers stimulates careers, while interactions with industry does not; (2) The researcher's scientific network activity declines after about 20 years while industry collaboration continuously increases; (3) Global innovativeness (the degree to which an individual is receptive to new ideas and makes innovation decisions independent of the communicated experience of others) positively influences science–science interactions. |
| Walsh et al. (2008) | (1) How have university–industry interactions changed in Japan since the mid-1990s?; (2) Is Japan different from the US regarding these interactions? | Questionnaire mailed to 2557 Japanese academics. The first wave included University of Tokyo engineering faculty (2003–2004); the second wave (2004–2005) included engineering faculty at the other universities and biomedical faculty at all 15 universities. 57% response rate. | Descriptive | (1) Ties to other sectors; (2) Changes in the research environment, types of ties with firms, channels of access, patenting and reasons for patenting; (3) Research results, including publications, patents and licenses | (1) They find a significant increase in commercial activity since the mid-1990s, especially with small- and medium-sized enterprises; (2) Scientists are increasingly considering business potential when choosing projects; (3) No increased barriers to access research tools; (4) University–industry interactions are mainly represented by informal ties and gift-exchange. |
| Welsh et al. (2008) | What are the views of academic researchers on university–industry relationships? | In-depth interviews with 84 university scientists at 9 US universities with research programmes related to agricultural biotechnology | Descriptive | (1) Researchers' views of characteristics of industry relationships; (2) Researchers' views of purpose of university IP policies | (1) Academics believe that working with industry can restrict communication among scientists (problems for scientific networks, publications); (2) They believe university IP policies should shield their work from opportunistic behaviour and at the same time attract industry (3) Researchers believe universities use their IP policies primarily as revenue raising vehicles and second, to address public good issues |

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