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In good company: The influence of peers on industry engagement by academic scientists

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Abstract

Recent research has explored behavioural peer group influences on the engagement of academics with industry but does not explicitly address under which circumstances these influences are more pronounced. Analyzing multi-source data for 1200 UK academic scientists and engineers, we find that the behaviour of peers shapes individual engagement behaviour; yet, the effect of social learning is stronger for individuals in the early stages of their careers and weaker for star scientists and academics with previous industry experience. Although peer effects appear to be strong, we find no evidence of organization-level effects. We explore the implications of our findings for research on professional

organizations and policies to encourage academics to engage with industry.

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In good company: The influence of peers on industry engagement by academic scientists

INTRODUCTION

Proactive behaviour by organizational members is often linked to positive outcomes at both the individual and organizational levels (Grant and Ashford, 2008). Individuals engage in proactive behaviour when they take the initiative to improve current circumstances or create new opportunities (Crant, 2000). One of the manifestations of such behaviour is individuals' attempts to supersede the routine components of their jobs and engage in activities that go beyond what is expected within an organizational environment. For example, proactive behaviour is associated with outcomes such as innovation or entrepreneurial initiatives (Becherer and Maurer, 1999, Crant, 2000, Parker, 1998).

Proactive behaviour is particularly relevant in professional contexts where highly-skilled individuals operate relatively autonomously of their managers but in close contact with their customers or constituencies (Mintzberg, 1983). Much work has a high non-routine content and work packages are largely indivisible, leaving individuals responsible for complex assignments or projects as opposed to single tasks (Greenwood et al., 1990). Hierarchical control mechanisms are less effective therefore than management structures that rely on individuals' proactive approaches to tackling tasks and resolving challenges (Von Nordenflycht, 2010).

Academic science is a good example of such a context. Universities are professional bureaucracies (Litwak, 1961) whose members are oriented strongly towards their audiences, that is their academic communities (Crane, 1972). The relatively specialized skills of academics, like other knowledge workers, grants them considerable bargaining power over their organizations (Von Nordenflycht, 2010), providing them with considerable autonomy over the choice of work topics and allocation of time. Academics pride themselves on their autonomy to define work programs and often are willing to pay for this privilege by accepting lower wages than those that could be obtained in industry (Stern, 2004).

In this paper, we explore a particular type of proactive behaviour practiced by academics: engagement with industry. This activity includes joint research with industry, contract research, consulting and other collaborative interactions that are highly valued by industrial enterprises (Cohen et al., 2002). Work on the antecedents of this type of proactive behaviour by individual academics has emphasized its social dimension, arguing that this behaviour is driven by attributes of the social context in which the academic works. Academics orient themselves to the attitudes and behaviours of their immediate colleagues, the prevailing local norms and the local leaders (Bercovitz and Feldman, 2008, Louis et al., 1989, Stuart and Ding, 2006). Work in this area has advanced this field by extending the idea that behaviours are a mere function of individual characteristics. However, questions remain about the precise mechanisms that make the social context relevant for shaping individuals' behaviours. For instance, we know little about whether local effects are exerted by a common culture, or norms, collective learning and imitation, or hierarchical imposition of policies.

In this paper, we argue that local *peers* play a key role in determining academics' individual behaviours. Individual engagement in proactive behaviour mimics the behaviour of workplace peers, i.e. of individuals of the same rank. We develop hypotheses to test the idea that these peer effects are generated by two distinct mechanisms. The first mechanism is social learning, indicating that individuals reduce uncertainty by following the behaviour of their peers (Bandura, 1977, Nanda and Sorensen, 2010). The second is social comparison whereby individuals choose local peers to act as a reference group (Hyman, 1942, Ibarra and Andrews, 1993). While social learning is an indication of cooperative attitude, the incidence of social comparison suggests that rivalry is also at play, and that individuals compare with one another in order to advance their careers in a competitive professional environment.

We test our hypotheses using multi-source data on 1,500 academic scientists in a range of disciplines, in UK universities. The data are drawn from survey information, research council records, and other sources. We make particular efforts to address the co-called reflection problem common to econometric studies of peer effects on individual behaviour (Manski, 1993), which can result in spurious correlation. The reflection problem states that evidence of peer effects is likely to be overstated in studies where the average behaviour of a group is translated as explaining individual behaviour. We undertake several tests to rule out possible alternative explanations for real endogenous peer effects.

Our study highlights the extent to which proactive behaviour in professional contexts is shaped by the behaviour of the focal individual's peers. We are able to pinpoint the precise nature of social influence and simultaneously to exclude a variety of other mechanisms that may be responsible for generating behaviour alignment in local work contexts. We show that individuals look to their immediate peers for their orientation, both collaboratively via learning as well as more competitively via social comparison. At the same time, we note the absence of effects exerted by local social norms in informing individuals' engagement behaviours implied by some previous research. Our results suggest that there are two, potentially substitutable paths that determine industry engagement by academics, or proactive behaviour in professional environments more generally. One path is represented by the accumulation of experience with respect to the behaviour in question; the other rests on perceived competition amongst individuals. Our findings have interesting implications for how specific proactive behaviours might be promoted within local work contexts.

THEORY BACKGROUND

Academics have different degrees of autonomy over specific aspects of their job roles. For instance, the allocation of teaching duties is an area where many academics enjoy less discretion compared to other areas of academic activity. However, academia is unique in allowing individuals to engage proactively in a wide range of diverse activities, from becoming a start-up entrepreneur, to acting as a government advisor, to taking on a role in civil society. Chief amongst the work areas where academics have considerable discretion is engagement with industry partners. While teaching and conducting research were the traditional mainstays of academic work, in recent years, individual academic's engagement with industry has become important for faculty, university managers, and policy-makers (Markman et al., 2008). Increased regard for industry engagement has been driven partly by new technological opportunities, such as biotechnology and computer science (Mowery et al., 2001), and the way that universities have responded to them. Governments are regarding universities as "engines of economic growth" (Feller, 1990) and are seeking to encourage universities to be entrepreneurial and to increase their engagement with industry. In addition, universities are making their own concerted efforts to build technology transfer functions and enhance their receptivity to industry activities (Ambos et al., 2008, Markman et al., 2009, Owen-Smith, 2003).

For the individual academic, these developments have resulted in new opportunities for proactive behaviour (Rothaermel et al., 2007). Engagement with industry takes many different forms and therefore affords individuals with opportunities to “craft” their jobs by actively shaping both the tasks and the relationships around them (Wrzesniewski and Dutton, 2001). While the decision to found a company and perhaps to abandon university employment in order to become an entrepreneur is an extreme variant of this behaviour, it is more common for academics continue with their research careers and engage with industry in ways that may include patenting and licensing, collaboration and consulting (Agrawal, 2006, Link et al., 2007, Owen-Smith and Powell, 2001, Perkmann and Walsh, 2008). Engagement in any of these latter types of activity is proactive behaviour since it involves personal initiative and effort to approach and win industrial partners. Academics also have more freedom to decide about engagement with industrial partners than over their teaching loads and which courses should be offered. Autonomy is an important antecedent of proactive behaviour because it allows the choice to adopt the behaviour or not, which discretion is not available in more structured work situations (Grant and Ashford, 2008). In addition, at many universities, engagement with industry does not count towards career advancement in the same way as the almost universally used measures of publication and other research-related outputs.

Extant work looks at what determines individual industry engagement behaviour at universities. While a number of studies explores the role of individual-level factors in informing academics’ engagement, there is a stream of research that suggests that the social environment in which individuals operate plays an important role. Louis et al. (1989) found that local norms were more powerful predictors than individual characteristics in terms of engagement with industry. Being embedded in an academic department with a culture that is supportive of entrepreneurial activities can help counteract the disincentives created by a university environment that does not recognize such efforts (Kenney and Goe, 2004). Using a sample of US-based life scientists, Stuart and Ding (2006) found that the more university and divisional colleagues and co-authors were involved in private sector firms, the more likely an individual academic would be entrepreneurial.

This work has shifted attention away from individual characteristics towards considering how the local social environment may stimulate proactive behaviour among academics. A qualitative study on university patenting by Owen-Smith and Powell (2001) provides a graphical illustration of how successful commercialization by immediate peers and the ensuing prestige, affected the aspirations of other individuals. Thus, incidences of success can be powerful forces for work colleagues, providing role models and pointing to the feasibility of commercialization behaviour (Kassicieh et al., 1996, Wright et al., 2004). Bercovitz and Feldman (2008) confirmed the presence of such peer effects in their study of medical researchers, which found that individuals were more likely to disclose inventions if their departmental colleagues of similar seniority did so as well.

These studies have generated important insights into how academics' social workplace environments shape their industry engagement but we lack knowledge about the social environment mechanisms that promote individual proactivity. We develop a framework that emphasizes the role of peers. A peer group is a specific type of reference group which the individual takes into account when selecting a behaviour amongst several alternatives (Hyman, 1942, Kemper, 1968). An individual's peers are of similar rank and have similar attributes to the individual, and belong to his or her immediate social context. The influence of peers on individual behaviour has been documented in many different empirical settings, including neighborhoods (Dietz, 2002), education (Coleman, 1966, Jackson and Bruegmann, 2009), movie sales (Moretti, 2011), health plan choices (Sorensen, 2006), and workplace contexts (Lazega, 2000, Nanda and Sorensen, 2010).

HYPOTHESIS DEVELOPMENT

In developing our hypotheses about how an academic's engagement with industry is influenced by peers, we consider departmental colleagues of similar rank as the salient peer group for the academic's work-related behaviour. The department is a central organizational feature of academic life and is constituted by the community of immediate work colleagues. Although departments may be composed of smaller units, "the department" is the principal locus of decision-making in academia (Alpert, 1985). Working in a department imposes obligations and responsibilities on academic staff, such as sharing teaching workloads, participating in departmental committees, and the like. Hiring, promotion, and applications for tenure are normally decided at department level before consideration by the university organization. Within the same university, departments may differ about expectations related to scholarship, organizational citizenship behaviour, approaches to commercialization, etc. In this context, there are two mechanisms that lead to individuals being influenced by the behaviour of their peers.

First, individuals look to their peers for cognitive orientation, and adopt behaviours through vicarious learning (Bandura, 1977, Manz and Sims, 1981, Nanda and Sorensen, 2010). Peers operate in the individual's immediate proximity, hence their actions are extremely visible and they provide models of how to pursue opportunities and resolve problems. Academic careers involve investment in discipline-relevant knowledge and adoption of the modus operandi of academia (Stephan and Levin, 1992). The proximity of departmental colleagues to the individual allows their behaviour to be easily observed, providing opportunities for learning and validating assumptions about how to act (Manski, 2000). Peers may actively support this learning process by sharing experience and guiding colleagues. New ideas require early support, nurture and examination, all of which local colleagues can provide, which will give signals about the potential scientific value of the idea (Oettl, forthcoming). Since in the early stages, many new ideas can be expressed only incompletely (Zucker et al., 2002), face-to-face communication with trusted local colleagues can provide a low-cost and efficient mechanism to assess the value and viability of an early stage scientific idea.

Like pure scientific work, working with industry and commercializing research also require specific skills, which differentiate individuals (Owen-Smith and Powell, 2001). Methods and techniques in novel areas of science and technology often develop locally because they are incompletely codified, and the tacit knowledge is shared with departmental colleagues (Agrawal, 2006). Making contact with potential industrial partners, managing relationships well, and recognizing the economic or technological value of scientific findings are non-trivial activities that require skill and experience. Learning from others about how to engage with industry partners and from their experience, encourages individuals to engage in similar behaviour. Especially in conditions of uncertainty, referent others are used to establish a more accurate view of reality and make judgments about the desirability and feasibility of a specific behaviour (Turner, 1982).

A second peer effects mechanism is comparison with a chosen reference group (Hyman, 1942, Ibarra and Andrews, 1993, Merton and Kitt, 1950). The peer group provides a standard or check point that can be used to evaluate a situation, and particularly the individual's position in it (Shibutani, 1955). Peer groups can be a yardstick for ambition, based on the desire to relate to and be accepted by a group. Individuals tend to compare themselves with others whom they consider as having similar attitudes or abilities, and their aspiration are influenced by what they perceive to be the level of achievement of the reference group (Festinger, 1954). In academia, this means that junior members of faculty will compare themselves to colleagues with similar experience, rather than to senior colleagues who are out of reach in terms of current levels of achievement. Engaging with industry is one area that is likely to involve comparison with a department reference group. Attracting industry funding for personal research projects, or engaging in lucrative consulting projects, are activities where outcomes are uncertain; comparative self-evaluation with peers can be useful to build confidence. Individuals observe their colleagues and establish individual ambitions based on emulating the observed behaviour. Self-categorization theory (Hogg and Abrams, 1988, Turner et al., 1987) suggests that uncertainty promotes in-group identification and makes the members of an individual's peer referent group the focus of social comparison. The above considerations lead us to hypothesize that:

H1. The extent of an academic's engagement with industry is positively associated with the extent of industry engagement of their departmental peers.

H1 describes an alignment between individual behaviour and the aggregate behaviour of the peer group and describes two possible mechanisms that generate this alignment. In order to establish whether both mechanisms are at work, we investigate how peer group effects are reinforced or reduced by the characteristics of focal individuals. Examining how individual characteristics moderate alignment with peer behaviour will allow us to infer which mechanisms are at work.

First, we consider the individual's previous professional experience and stock of knowledge accumulated from previous learning. Academics with previous experience of working in industry will be more familiar with the world of industrial research and able to benefit from a wider range of resources and information relevant to collaboration with private firms. These individuals face less uncertainty in collaborating with industry compared to colleagues with no previous experience. For instance, previous experience provides superior knowledge on the benefits that can be expected from engagement with an industry partner, such as access to a broader range of research problems which may promote the combination of scientific discovery with technological innovation. Individuals with industry experience will be more familiar with the needs of industrial partners and their approach to establishing and managing research projects (Mansfield, 1995); they will be better able to cope with the tensions between satisfying academic and industrial objectives (Boardman and Bozeman, 2007). Inexperienced individuals may find it difficult to reach agreement with industrial partners about the focus of the research project and the timing and nature of dissemination of research findings. Resolving these issues involves a learning process which, for those with no previous experience of working with industry, can be facilitated by departmental peers. Mimicking the behaviour of peers can substitute for industry experience. If academics' susceptibility to peer behaviour is moderated by the extent of their previous industry experience, we have support for the assumption that peer effects in academic departments are driven by learning mechanisms. We hypothesize that:

H2: The effect of an individual's departmental peers on the extent of his/her industry engagement is negatively correlated with the individual's number of years of experience of working in industry.

Next, we consider the impact of the second peer effect mechanism, i.e. the comparison process. A characteristic likely to influence individuals' propensity to take behavioural cues from their work peers is their own seniority within the organization. The influence of seniority on the individual's susceptibility to peer effects is likely to indicate the presence of social comparison in generating this peer effect. Individuals at the beginning of their careers are more concerned about advancement than more senior colleagues (Baldwin and Blackburn, 1981, Jacobs et al., 1991). Professional competition in academic science is fierce, and success depends heavily on what the individual achieves in the early stages of his or her career. The choice of junior colleagues to engage in specific discretionary behaviours therefore is often informed by the desire to advance their career prospects. Competition for jobs exists among people at similar stages in their careers; therefore, for each individual the local peer group is representative of the broader reference group constituted by these candidates. Individuals will compare themselves to local colleagues of the same ranking and use them as a benchmark when selecting their own behaviours. This comparison process will be particularly important in relation to behaviours that are highly discretionary. For some activities the existence of formal rules will be sufficient to orient individual behaviour; however there are no fixed prescriptions for activities such as engaging with industry, and young academics in particular will look to their peers for clues about how to behave.

H3: The effect of an individual's departmental peers on the extent of his/her industry-engagement behaviour is lower for more senior individuals.

Next, we investigate how individual performance affects academics' susceptibility to peer behaviour. It has been documented that a small group of highly effective researchers plays a disproportionate role within a scientific community in terms of productivity (Zucker and Darby, 1996). "Star" scientists also outperform their colleagues in terms of engagement in the commercialization of research and are responsible for a significant share of the economic activities at universities (Zucker and Darby, 1996).

High performance is closely correlated to status within the scientific community. Over time, the status of stars becomes self-reinforcing because reputation attracts larger flows of resources, and provides higher visibility, resulting in more attention to the research outputs of these individuals (Merton, 1968). It is likely that these excellent scientists will choose a reference group with which to compare themselves differently from their "average" departmental colleagues. Social comparison often involves selective search for clues as to the similarity of peers to oneself (Mussweiler and Strack, 2000). For star scientists, "similar others" will likely be represented by other stars in the scientific community rather than departmental colleagues. "Average" researchers will probably prefer to compare themselves with equals amongst their academic departmental colleagues. Thus average performers will tend to follow the behaviour of departmental peers more than will star performers, which is further confirmation of the presence of social comparison processes underpinning peer effects in academic departments. We can hypothesize that:

H4: The effect of an individual's departmental peers on the extent of his/her industry-engagement behaviour is lower for star scientists.

Figure 1 illustrates the hypothesized model.

Insert Figure 1 about here

DATA AND METHODOLOGY

Data

To explore our hypotheses, we exploited a unique dataset covering a population of 6,200 academic researchers in the UK, compiled from various sources. These include information on this population of scientists from the records of principal investigators and co-investigators who received grants from the UK Engineering and Physical Sciences Research Council (EPSRC) in the period 1992-2006. The EPSRC is the largest research funding body in the UK and, in 2008, disbursed £740m for research across all fields of engineering, mathematics, chemistry, and physics. The EPSRC encourages partnerships between researchers and third parties, such as private firms, public bodies, non-profit organizations, etc. However, for most research projects there is no requirement to have an industrial partner. The selection of projects is based solely on peer review. We used the EPSRC data to obtain information on each academic's research funding profile, including amounts of funding received. These data are comprehensive and cover all academics granted EPSRC funding in the UK over a period of 15 years.

First, we conducted an Internet-based survey of the 6,200 academics listed in the EPSRC records who were still listed as active academics on their respective university websites. The questionnaire covered various aspects of researchers' engagement with industry, such as engagement types and frequencies, and attitudes towards engagement. The survey instrument exploited items and scales deployed in previous surveys of academics (Bozeman and Gaughan, 2007, D'Este and Patel, 2007, Link, Siegel and Bozeman, 2007) and included several questions exploring individuals' attitudes towards engagement and entrepreneurship. A draft version of the questionnaire was pilot tested with 30 academics at Imperial College London. The final questionnaire was administered to the whole population between April and September 2009; it was introduced by a covering letter signed by the

Chief Executive Officer of the EPSRC, followed a few days later by an email containing a personalized link to access the survey. Two further emails and telephone reminders were sent to non-respondents. We obtained a total of 2,194 completed questionnaires, corresponding to a response rate of 36%.

Second, we drew on data collected from a survey administered to the same population in 2004(D'Este and Patel, 2007) which also asked about the frequency of engagement with industry; 735 individuals answered both waves of the survey.

Third, we matched our sample with the population of academics included in the 2008 Research Assessment Exercise (RAE) (HEFCE et al., 2008). The RAE was a government-mandated program to assess the quality of research of all universities and colleges in the UK. The assessment was carried out via disciplinary panel reviews of the publications, research environment, and research ranking of each department. The results were used as the basis for determining the allocation in subsequent years of research funding to universities not allocated via competitive bids for grants. RAE submissions contain information on "units of assessment", usually departments or similar units. These submissions contain rich information about the character of the department, including the size of the unit of assessment and the amount and nature of funding it received in each of the previous seven years. We used this information to develop measures of the departmental environment of each individual in our sample.

Fourth, we matched the universities included in our sample with data derived from the government's Higher Education-Business and Community Interaction Survey (HE-BCI) conducted in 2008, covering the years 2005-2007 (HEFCE, 2008). This annual survey examines the exchange of knowledge between universities and society. It collects university level financial and output data on a range of activities, from the commercialization of new knowledge, through the delivery of professional training, consultancy, and services, to community-oriented activities.

Fifth, to capture details on respondents' scientific productivity, we used bibliographic information collected from ISI Web of Science, including number of an individual's journal articles, number of citations, names of the journals, and associated disciplines.

Our final data source was Eurostat (2003) which provides information on the university region (NUTS2 level), including Gross Domestic Product (GDP), business Research and Development (R&D) expenditure, and patent applications. These data are informative about the regional economic context in which academics operate; some local environments offer greater opportunities than others for industrial engagement.

We performed several checks on the sample used for the analysis to ensure its representativeness of the population being studied. First, to check the reliability of our response pool, we conducted some tests on the response population, looking for sources of bias in our sample. In particular, we analyzed whether there were differences in the typology of university of affiliation of the respondents compared to the rest of the sample. We performed a Wilcoxon-Mann-Whitney test and found no significant difference. Second, because only grant holders were targeted, there was a risk of sample selection bias since non-grant holders might behave differently in terms of engagement with industry. Since we did not have information on academics who had not received a grant in the period 1992 to 2006, as a proxy for non-grant holders we used the group of academics in our survey who had not received a grant in the previous five years (2000 to 2006). We compared their level of involvement with industry with that of academics who had received a grant in 2000-2006 and found no statistically significant difference.

Dependent variables

Our dependent variable captures academics' industry engagement behaviour through the construction of an index. The individual *industrial involvement index* (III) is a modified version of the index developed by Bozeman and Gaughan (2007). We used information from our survey data on types and frequencies of academics' industry engagement to construct the index (see Table 1). This list covers a broader range of industry engagement forms than captured in previous studies of peer effects on academic entrepreneurship because it includes a range of teaching, research, and consultancy engagements with industry.

Insert Tables 1 and 2 about here

The III was constructed as follows. First, for every type of industry engagement we established whether the researcher had collaborated or not ("occurrence", denoted by b_j); see Table 2 for how we coded response items. We computed frequency of each type of engagement for the whole population:

$$f_j = \frac{\sum_{n=1}^{N} b_{n,j}}{N} \quad (1)$$

where *j* is the type of industry engagement, *n* is the individual and N is the total sample (N=1,895). We constructed the index by multiplying the actual number of interactions declared by each academic for each channel (*Tj*) and the frequency of its non-occurrence (1 - f_j), and summed the scores.

$$III_n = \sum_{j=1}^{9} T_j \cdot (1 - f_j) \quad (2)$$

The index takes account of the "difficulty" and infrequency of certain activities such as the creation of new physical facilities relative to others such as attending industry sponsored meetings. We extend the measure proposed by Bozeman and Gaughan (2007), using more granular information that takes account of the actual number of occurrences of different types of engagement for every individual, as opposed only to occurrence.

Independent variables

Our main independent variable expresses departmental peers' industrial engagement. Following Bercovitz and Feldman (2008), we define peers as an individual's departmental colleagues of the same academic rank. We assume that to the extent that faculty members in a certain position (e.g. professors) socialize primarily with their academic equals, their choices related to collaboration with industry are likely to be influenced by the actions of other members of the faculty of the same rank.

Peers' engagement is an average of the industrial involvement of peers (not including the focal individual). These data are taken from our survey and matched with the RAE unit of assessment question about individuals' departmental affiliation. Meaningful measures of peer behaviours require information on at least one researcher other than the focal individual. We therefore excluded individuals where there were no responses from peers, which left 1,344 valid observations. The average size of cohorts per department was 11 individuals, which helped to ensure that our results were not driven by the views and behaviour of single researchers in small departments.

To analyze the social learning component of peer effects, we interacted the main independent variable with number of years of work experience in the private sector (*industry experience*). Individuals who have been exposed to the *modus operandi* of industry in other contexts will be less reliant on peers when deciding about collaboration with private companies.

Furthermore, to explore the social comparison mechanisms of peer effects, we interacted the main independent variable with the researchers' *academic age* (or number of years of experience as a researcher, defined as their age minus their age when being awarded their PhD). We also interacted peers' engagement with a dummy variable for *star* scientists. In line with the literature on star scientists (Azoulay et al., 2008, Zucker and Darby, 1996, 2001), we define star scientist as those academics who are in the top 1% of the distribution of citations in their discipline and who are in the top 25% of the distribution of grants received from the EPSRC in our sample.

Control variables

We included a range of control variables to account for individual, department, university, and regional level effects on a researcher's experience with industry. A first group relates to the academic's individual characteristics. We included demographic characteristics such as *gender* and *academic rank* (coded as a dummy variable indicating professor status) (Link, Siegel and Bozeman, 2007). We used a dummy variable for a British doctoral degree (*British PhD*), and a proxy for the quality of the institution awarding the PhD degree (e*lite PhD*), coded as a dummy variable indicating whether the institution is part of the Times Higher Education Supplement (2004) list of worldwide top universities. This was based on information from the survey responses. We also controlled for researchers' quality and productivity. We included the total amount of research funding received from EPSRC in the period 2000-2006, standardized by the average level of funding of other researchers in their discipline (*individual grants*). We controlled for the scientific productivity of researchers in the same period of the grants (2000-2006) by including the number of publications on the ISI Web of Science identifying the researcher as an author (*publications*). We also included a variable for *intrinsic* motivation to be an academic researcher. Adherence to the traditional academic norms of openness may influence scientists' attitudes to collaboration. A study of 98 US professors conducted by Renault (2006) indicates that agreement with the values of academic capitalism (as opposed to Mertonian values) is a strong predictor of involvement with industry. Finally, we controlled for scientific discipline by introducing a dummy variable (*basic discipline*) identifying the disciplines mathematics, chemistry, and physics.

A second group of variables was related to department's characteristics, taken from the RAE 2008 database. We included in the regressions research income received between 2005 and 2007 from industry per Full Time Equivalent (FTE) staff (*department industry funds*). Although we were unable to observe the formal rules governing industry collaboration in a department, we believe that the amount of funding received from private companies is a good proxy for these norms since we would expect that departments heavily funded by industry would encourage their members to engage in collaboration with industry. We controlled for *department research quality* measured as the percentage of staff rated 'internationally leading' and 'international excellent', which are the measures of research quality used for allocating funding in the RAE. These measures help to capture the opportunities for industry engagement offered by the individual's department.

The third group of variables captured university characteristics. We controlled for institutional involvement in commercialization and collaboration activities by stock of *university patents* per FTE, and income received from industry per employee in the period 2005-2007 as *university industry funds*. These measures account for the level of commercialization efforts in the university as a whole, and the degree of institutionalized support for these activities. Individual engagement may be enhanced by a formal support infrastructure and institutional incentive mechanisms (Landry et al., 2006). We assessed the profile of the universities in the sample by introducing measures of their quality based on their RAE 2008 score (*university research quality*), and incorporating a dummy for *group* (Russell Group, Red Brick, 1994 Group, New Universities) to account for the strong institutional differences between groups of universities in the UK. Large, and high quality universities may offer more opportunities for industry collaboration than small, less good quality universities (Owen-Smith and Powell, 2001).

The fourth group of variables is for the regional level. We identified the regions (NUTS2 or 37 UK regions) in which the universities in our sample were located and included measures for economic and innovation activity. We included variables for Gross Domestic Product (in € millions) (*region*

GDP), business R&D expenditure (in € millions) (*region R&D*) and the number of EPO patent applications per million of inhabitants (*region patents*). These measures help us to account for different levels of demand for academic knowledge in the local environment (Krabel and Mueller, 2009).

Identification strategy

Empirical analysis of peer effects can produce spurious correlations and suffer from the identification problem described by Manski (1993). We dealt with these methodological issues as follows.

First, we addressed the possibility that local sorting processes for hiring and retaining academic staff and individual self-selection into departments might bias results. Keen collaborators with industry may self-select into or get hired by departments where commercialization efforts are more common. To rule this out we used information on those individuals in our sample who, according to their grant records, moved between universities by extracting the researchers' two most recent affiliations. We also gathered information on the level of commercial activity in the departments of origin and destination of each mobile researcher based on amounts of funding from industry sources according to RAE records. If a researcher moved for industry engagement related reasons, we would expect some variation in the level of commercial activity between the original and the destination departments. Comparison of the values for each respondent based on a Wilcoxon signed-rank test, we found no statistically significant difference between the levels of income received from industry by the department of origin and the destination department ($z = -1.538$, Prob> $|z| = 0.1241$).

It would seem that researchers do not move based on the external engagement profile of a department, which is strong evidence against the presence of a sorting problem in our analysis. The result held when we performed the analysis on the subsample of 'highly engaged' academics (those in the top 25% or top 10% of the industrial engagement index distribution). The data show that academics move because of the research quality of the university and the department. The same test applied to the difference in the quality of the origin and destination universities, and the difference in quality of the departments involved, showed statistically significant differences (in both cases the destination is of higher quality on average).

Second, the peer effect we seek to measure should be a true endogenous effect by which the propensity of a person to behave in some way varies with the behaviour of the group to which s/he belongs. Simple observation of a correlation between individual and group behaviours may in fact hide other mechanisms at play. A correlation effect may be due to unobservable characteristics, which influence the behaviours of both the individual and his or her peers. Individuals may behave similarly to the group because of their similar individual characteristics. We addressed this problem by including detailed information on departments, universities, and regions. Moreover, we conducted an additional analysis aimed at reducing the effect of shared unobservable contextual characteristics on individual behaviour, following Bercovitz and Feldman (2008). To this end, we included an independent variable in our model measuring researchers' engagement in the 'outside peer group', i.e. members of the same department but of different rank. We defined *outside peers' engagement* as the average industrial engagement index of the outside peer group. This allowed us to investigate whether an individual's decision to engage was driven by unobservable departmental characteristics rather than imitating peers. To take account of outside peers, we required information on at least one additional individual, in the same department but of a different rank, which reduced the number of our observations to 1,192.

Third, there are exogenous (contextual) effects: the propensity of an individual to behave in some way may change with the exogenous characteristics of his or her peers (Manski, 2000). For instance, industry collaboration behaviour may be based on the characteristics, such as age and gender, of co-workers. To control for this possibility, we computed the average academic age of the focal individual's peers (*academic age peers*) and included it in one of the models.

Fourth, average group behaviour may be influenced by the behaviour of the individual member, introducing a "reflection problem" (Manski, 1993, 2000). It has been suggested thatreflection problem can be alleviated by examining peer effects on the basis of attitudes and perceptions rather than manifest behaviours: this makes it easier to differentiate between preference interaction and expectations interaction (Manski, 1993, 2000). We performed an analysis using a perception variable measuring the extent of the benefits of industry engagement perceived by the individual's peers. We operationalized extent of perceived benefits from industry collaboration as the total number of single benefits indicated by the individual as “important” or “very important” in the questionnaire (items reported in Table 3). The list of benefits builds on D’Este and Patel (2007) and refers to both the personal and professional benefits from working with industry. This information allowed us to construct the *peers’ benefits* measure based on the average number of benefits perceived by the individual’s peers in each department, excluding the focal individual. By using subjective evaluations of the benefits on industry collaboration engagement, we were able to mitigate some of the measurement issues associated with the reflection problem (Manski, 1993).

Insert Table 3 about here

We conducted another analysis to address the issue of reflection by isolating the behaviour of recently recruited academics. In his analysis of social learning and health plan choice, Sorensen (2006) assumes that the health plan choices of *newly hired* employees are influenced by co-workers but not vice-versa. Our data allowed us to perform an analysis making a similar assumption. Since 523 of the individuals in our sample had responded to the 2004 survey we were able to identify individuals who had moved universities between 2004 and 2009 (52 individuals). They were labeled *movers* and assumed to be influenced by the behaviour of their new colleagues but not vice-versa since the observation period was too short for the reflection mechanism to occur.

Estimation

We employ an ordinary least squares (OLS) model to investigate the impact of peers’ behaviour on individual industry collaboration. To use this kind of model, we must assume that the dependent variable is normally distributed: we therefore employ the natural logarithm of the individual industrial involvement index. To address the possible problem of heteroskedasticity, we use robust standard errors. Another assumption of OLS is that standard errors are independently and identically distributed; however, this may be violated. If errors are clustered (i.e. if observations within a certain group are correlated in unknown ways), the OLS estimates will be unbiased but the standard errors may be wrong, leading to incorrect inferences. Since the respondents in our sample are affiliated to different disciplines, we can expect some group correlation which we are not able to observe; therefore we clustered errors by scientific discipline. As a robustness check we clustered errors also by department and university; the main results were unchanged.

RESULTS

Tables 4 and 5 present the descriptive statistics and correlations for all the variables employed. Correlations generally were low to moderate indicating that multicollinearity was not a problem in the estimations. The variance inflation factor (VIF) for the main specification was 2.43, which was well below the value of 10 commonly recognized as indicating multicollinearity. The appropriateness of using weights for the industrial involvement index can be gauged from the pattern of academics' engagement across different disciplines. Some activities are more common than others. For example, nearly 83% of respondents attended conferences with industry participation, while just 17% were involved in the creation of physical facilities, such as laboratories, with industry partners, and only 3% had started a company. Another 8% of our sample had not engaged with industry in any form and a small proportion of individuals did not perceive any important benefits from industry engagement. Seeking additional research funding was seen as the most important driver for industry collaboration.

Insert Tables 4 and 5 about here

Table 6 presents the results of our econometric analyses. Model (1) is a baseline model with the individual industrial involvement index as the dependent variable. Academic age has a negative and statistically significant effect on the level of engagement with industry, indicating a possible cohort effect. As observed by Bercovitz and Feldman (2008), the longer ago that the researcher completed his formal training, the lower the likelihood of collaboration with industry because, in the past, university engagement with industry was less relevant or even discouraged. Being a professor (*academic rank = 1*) has a positive and statistically significant effect: this finding is in line with previous research (Link, Siegel and Bozeman, 2007) and suggests that more experienced academics control more organizational resources and have greater license to engage in proactive behaviours such as collaboration with industry. Experience of working in the private sector (*industry experience*) is also positive and significant, which is also in line with previous research (Audretsch, 1998). Being intrinsically motivated to be an academic is positively and significantly related to individual engagement with industry: this perhaps indicates that academics who adhere to the norms of public science collaborate with industry in order to advance their research agendas (D'Este and Perkmann, 2011). Academics who attended UK universities are significantly more likely to engage with industry than those trained abroad, but a PhD degree from a high-status university (*elite PhD*) does not seem to have any effect. Being a high-performing scientist (*star*) is not significant in the regression, contradicting somehow the published literature which has reported that being highly productive in academic terms increases the likelihood of being involved in collaboration or commercialization activities (Zucker and Darby, 1996). Analyzing more in depth the scientific productivity of the researchers, the amount of EPSRC grant funding received is not statistically significant, while the number of publications is positively correlated to industrial engagement, which is in line with previous research on academic inventors (Agrawal and Henderson, 2002, Azoulay et al., 2007, Breschi et al., 2007, Fabrizio and Di Minin, 2008). Affiliation to a basic discipline has a negative and significant effect on industry engagement, confirming previous results (Link, Siegel and Bozeman, 2007). None of the department level variables has a significant effect. The quality of the university is negatively and significantly correlated with individual engagement: better universities receive more government funding and more funding from a wider spectrum of other sources and therefore are less reliant on industry to finance research projects. None of the regional level variables is significant in the regression.

Model (2) builds on the previous base specification but includes a variable for the level of peers' engagement. The explanatory power of the model increases significantly with the addition of the main independent variable: R^2 increased from 0.195 to 0.242. The influence of industry engagement of an individual's peers is positive and significant, suggesting that the actions of a researcher are affected by the behaviour of the other researchers of the same rank in his department, as predicted by H1. All the control variables maintain the same effect as in the baseline.

In model (3) we introduce the first moderator, previous industry experience, which resulted in significant improvement in the model's explanatory power. The interaction term is significant and negative: individuals who spent longer periods of time working in private companies are less influenced by their peers when choosing their engagement behaviour. H2 is therefore confirmed, indicating that having been exposed previously to the industrial logic is a substitute for social learning from academic colleagues. In Model (4) we test H3 and H4 by adding two moderators. First, the interaction term between academic age and peers' engagement is negative and significant as expected. Younger individuals rely more heavily than their senior colleagues on social comparison with their peers when deciding about engaging with industry. Second, the interaction term between *star* and peer's engagement, as expected, is also negative and significant: high-status individuals do not compare themselves with their departmental peers and therefore are less conformist and more willing to engage in deviant behaviours. Again, the change in R^2 is positive and significant. We find therefore that the social comparison component of peer effects seems particular relevant in our setting. Finally, in model (5) we test the full model. The signs are consistent with the previous specifications, and we observe a statistically significant increase in R^2. As a robustness check, we calculated an alternative specification of the main model that included university dummies and region dummies instead of the variables at the university and regional level. The main results are unchanged.

Insert Table 6 about here

Table 7 presents an analysis to test for possible sources of spurious correlation. Model (1) presents the main model testing the influence of peers' behaviours on individual behaviours for reference. To check for unobserved heterogeneity, which might explain the correlation between behaviours for other reasons than peer imitation, in Model (2), along with the main independent variable, we introduce an additional variable measuring outside peers' engagement. In this specification, the coefficients of the main independent variable and the controls remain unchanged, while the coefficient of the outside cohort engagement variable is not significant. This suggests that our results are driven by the identified peer effects, and not by some characteristics of the department that we cannot control for.

To rule out the possibility of contextual (exogenous) effects in the analysis, in Model (3) we introduce the average academic age of the peers of the focal individual. As expected, the coefficient of academic age peers is not significant: individual decisions related to industrial engagement activities are not influenced by an exogenous characteristic of the individual's co-workers.

Models (4) and (5) address the problem of reflection. Following Manski's (1993, 2000) suggestion we test the effect of peers' *perceptions* of the benefits from industry engagement (as opposed to manifest behaviours) on a focal individual's engagement behaviour. We find the effect of peers' perception of benefits on individual industry engagement to be positive and significant, reinforcing the presence of genuine peer effects. Model (5)is a standard analysis of the subsample of researchers who moved universities between 2004 and 2009. The coefficient associated with peers' behaviour is significant and positive, providing additional support for the argument that individual behaviour is shaped by peers' behaviour and not vice versa, assuming that recent movers are more likely to be influenced by their colleagues and that the time frame is too short for the mean behaviour of the group to be influenced by these new colleagues.

Insert Table 7 about here

DISCUSSION

Our analysis suggests that academics' engagement with industry is strongly informed by the behaviour of their departmental peers. Observing colleagues' behaviours appears to exert significant peer pressure on individuals to emulate such behaviour. Furthermore, we found that the influence exerted by peers is moderated by the individual's industry experience, academic age, and academic standing. Individuals with experience of working in industry are influenced less by their peers because they already possess knowledge about collaborating with firms. In turn, more junior individuals are more likely to be influenced by peers in deciding about their industrial engagement as they try to further their careers. Finally, star performers are less influenced by local peers and look farther afield for reference points for competing professionally.

Our findings provide several contributions to the literature. First, we extend the work on proactive behaviour within organizations by taking account of the relevance of the local social context. While recognizing the importance of individual (demographic and psychological) factors for explaining an individual's behaviour, we seek to redress the relatively 'undersocialized' view that has characterized the discussion on this topic (Grant and Ashford, 2008). Our interactionist perspective on proactive behaviour highlights the importance of the local social environment in influencing an individual to depart from the prevailing routines in the organization. This finding has implications for how we conceptualize the nature of proactive behaviour. While we tend to regard proactive behaviour as "exceptional", initiated by particular individuals with the characteristics and personal incentives to make efforts beyond what is expected, our findings indicate that this kind of behaviour arises as an effect of social learning and comparison within local work groups. Being proactive and working to achieve potential benefits for the organization, does not necessarily mean engaging in behaviour that is exceptional relative to that of one's colleagues but appears to be a collective phenomenon in which all colleagues are involved to some degree. Our results also have some implications for the study of professional services organizations because, in many respects, academic departments have features in common with practice areas in these organizations. Universities, like other professional services firms, are professional bureaucracies (Mintzberg, 1983) where highly skilled individuals work relatively autonomously with groups and "clients" external to their organizations. For all these organizations, the proactive behaviour of employees is crucial for acquiring external resources and getting the job done. Our study suggests that individual behaviour to a great extent is shaped by peers in the immediate work environment. Learning from and comparing with peers appears to have a major influence over an individual's decision to engage in behaviour over which they have discretion and which is not unequivocally prescribed by organizational policies. In this context, note that the influence of "outside peers", i.e. local colleagues who are either more junior or senior than the focal individual, is not important. This means that individuals are strongly oriented by what they perceive to be their generalized other, suggesting that immediate peer groups represent opportunities for generating professional identities which in turn inform individuals' attitudes and behaviours (Ibarra, 1999).

A second contribution is to the literature on university-industry relations and commercialization of university technologies. For a long time, researchers have been interested in what drives academic scientists to work in industry and possibly contribute to the transfer of knowledge and technology from university to industry (Haeussler and Colyvas, 2011, Louis, Blumenthal, Gluck and Stoto, 1989, Mansfield, 1995, Murray, 2002, Owen-Smith and Powell, 2001, Siegel et al., 2003). A recent stream in the literature highlights that individuals' behaviour is strongly informed by the social context in their universities or departments (Bercovitz and Feldman, 2008, Stuart and Ding, 2006). This study has identified the precise mechanism by which this local context influence occurs. We have highlighted that most local influence is due to one factor, i.e. peer effects. When deciding to engage in proactive behaviour such as industry engagement, academic scientists mimic the average behaviour of their departmental work colleagues who are at a similar stage in their careers. We show also that there are two mechanisms that produce this effect. One is social learning where scientists learn from observing colleagues' behaviours and the outcomes of colleagues' efforts and subsequently emulate these behaviours. The other is social comparison where scientists compare themselves with relevant others, such as their departmental peers. While social learning is a co-operative activity, social comparison suggests an element of rivalry and competition motivating scientists' proactive behaviour. In other words, academic scientists may decide to engage with industry because they aspire to achieve their colleagues' performance levels, for instance to improve their career prospects. While previous research has explored various facets of competition in academia, such as the race for priority in publishing (Hagstrom, 1974) and the struggle for resources (Merton, 1968), our findings suggest that competition may affect academic scientists' proactive efforts to collaborate or otherwise engage with industrial users of their research. An important implication of our finding is that industry engagement appears to be more closely aligned with academics' primary role of conducting scientific research than is suggested in industry engagement viewed as a somehow disconnected 'third mission' of academic work (Etzkowitz, 2003).

Our study also provides a broader view of academic entrepreneurship. Much of the research on university-industry relations has highlighted the incidence and impact of entrepreneurial activity by academic scientists, resulting in the filing of patents and the founding of academic spin-offs (Agrawal and Henderson, 2002, Shane, 2002). Our study complements this work by proposing the concept of proactive behaviour to describe academic scientists' engagement with industry partners and users. While certainly important as a means of technology transfer, patents and licensing represent only a small amount of the information transferred out from a university (Agrawal and Henderson, 2002). Using our industry involvement index, we are able to capture collaboration behaviours that are far more common than the types of behaviours explored in other studies. In many disciplines, large numbers of academic faculty routinely participate in collaborative engagement with industry via joint research, consulting, or contract research (D'Este and Patel, 2007, Gulbrandsen and Smeby, 2005, Louis, Blumenthal, Gluck and Stoto, 1989). Characterizing these as proactive behaviour allows us to take into account the fact that academics may exploit them for reasons other than to act entrepreneurially. These reasons may include resource mobilization for their academic research projects, as well as sources for new ideas that may shape their research agendas (Mansfield, 1995, Rosenberg, 1982). Proactive behaviour is a broader category that may include entrepreneurship but encompasses all types of activities that the members of an organization may undertake at their own discretion.

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FIGURES AND TABLES

Figure 1: Hypothesized model

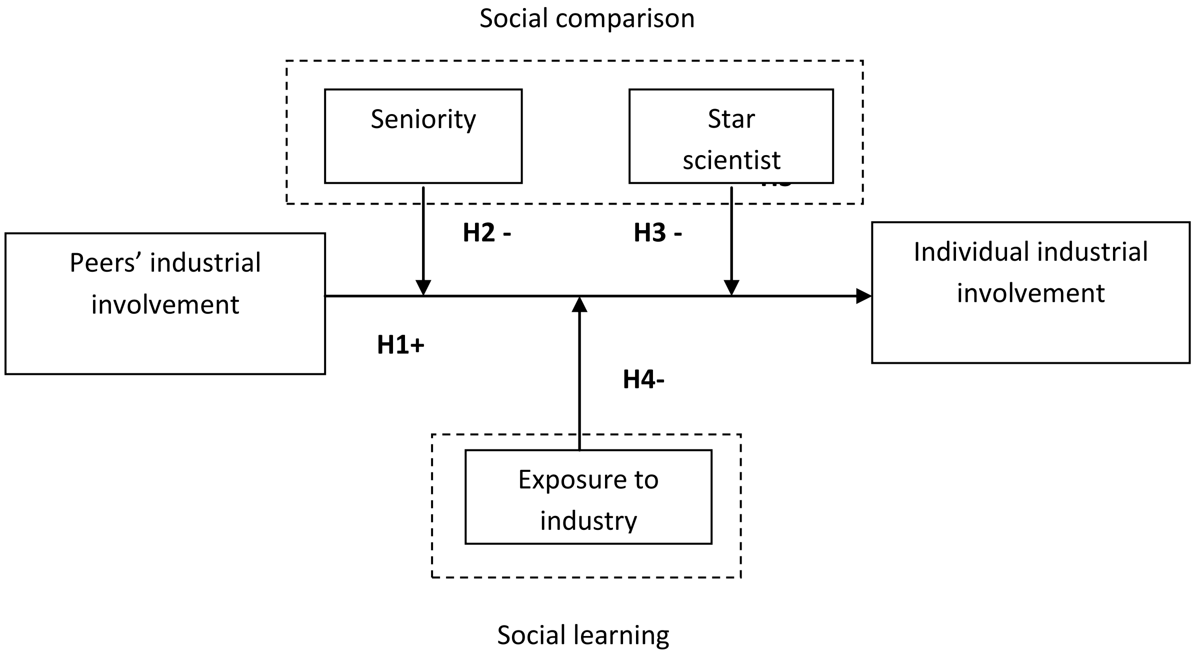

Table 1: Types of researchers' interaction with industry

Type of interaction (j)	Frequency % (b_j=1)
Attendance at conferences with industry and university participation	82.7
Attendance at industry sponsored meetings	63.6
A new contract research agreement	58.0
A new joint research agreement	57.5
Postgraduate training with a company (e.g. joint supervision of PhDs)	47.7
A new consultancy agreement	47.6
Training of company employees	30.4
Creation of new physical facilities with industry funding	17.3
Creation of a commercial venture	3.74

Table 2: Coding of occurrences of researchers' engagement with industry

Questionnaire answer (category)	0	1-2	3-5	6-9	>10
Occurrence (b_j)	0	1	1	1	1
Volume of interaction (T_j)	0	1.5	4	7.5	10

Table 3: Researchers' motivations for engaging with industry

Motivation	%of respondents[1]
Source of additional research income	69.7
Increasing the likelihood of application of my research outside academia	66.6
Raising awareness of problems that industry confronts	59.3
Building and sustaining your professional network	53.0
Keeping abreast of research conducted in industry	51.9
Getting inspiration for new research projects	50.8
Feedback from industry about viability of research	46.1
Access to materials or data necessary for research	40.1
Training of postgraduate students	34.5
Helping students to find employment in industry	33.6
Access to research expertise of industry employees	30.0
Improving the understanding of foundations of particular phenomena	24.4
Access to state-of-the art equipment, facilities and instruments	18.4
Seeking proprietary knowledge (e.g. patents)	12.3
Source of personal income	10.8

1. Percentage of respondents indicating 'very important' or 'crucial' on the survey.

Table 4: Descriptive Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
Individual engagement	1371	4.47	4.46	0	33.97
Gender	1371	0.11	0.31	0	1
Academic age	1371	21.07	9.87	1	60
Academic rank	1371	0.54	0.50	0	1
Industry experience	1371	2.77	5.26	0	45
Star	1371	0.08	0.31	0	3
Intrinsic motivation	1371	3.35	0.80	0	4
British PhD	1371	0.84	0.37	0	1
Elite PhD	1371	0.42	0.49	0	1
Individual grants	1371	1.00	2.04	0	27.28
Publications	1371	25.03	27.04	0	393
Basic discipline	1371	0.39	0.49	0	1
Russell Group	1371	0.62	0.49	0	1
Red Brick Universities	1371	0.18	0.38	0	1
Group 1994 Universities	1371	0.19	0.40	0	1
New Universities	1371	0.03	0.16	0	1
Department industry funds (per employee)	1371	179925.80	125988.20	3416.90	993625.1
Dept. research quality	1371	0.63	0.15	0.11	0.95
University patents (per employee)	1371	0.25	0.30	0	1.24
University industry funds (per employee)	1371	24.08	23.69	1.15	142.81
Univ. research quality	1371	2.68	0.19	1.75	2.98
Region GDP	1371	73013	55213.52	17116.70	193751.90
Region R&D	1371	1.78	0.97	0.93	4.29
Region patents	1371	76.48	58.33	0.07	198.89
Peers' engagement	1371	4.34	3.27	0	33.97
Outside peers' engagement	1229	4.23	3.20	0	33.97
Peers' academic age	1371	18.82	8.91	0	49
Peers' benefits	1371	6.08	2.70	0	15

Table 5: Correlation matrix

	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]	[13]	[14]	[15]	[16]	[17]	[18]	[19]	[20]	[21]	[22]	[23]	[24]	[25]	[26]
[1] Gender	1																									
[2] Academic age	-0.15	1																								
[3] Academic rank	-0.12	0.49	1																							
[4] Industry experience	-0.07	0.17	0.07	1																						
[5] Star	-0.03	0.34	0.20	0.15	1																					
[6] Intrinsic motivation	0.10	0.00	0.05	-0.08	0.02	1																				
[7] British PhD	-0.05	0.16	0.05	0.09	0.08	-0.01	1																			
[8] Elite PhD	-0.02	0.05	0.04	0.00	0.12	0.04	0.14	1																		
[9] Individual grants	-0.05	0.15	0.20	0.05	0.17	-0.02	0.10	0.07	1																	
[10] Publications	-0.05	0.18	0.29	0.00	0.28	0.05	0.05	0.08	0.16	1																
[11] Basic discipline	-0.01	0.06	0.04	-0.11	-0.01	0.01	-0.05	0.13	-0.01	0.13	1															
[12] Russell Group	0.00	0.03	0.04	-0.09	0.10	0.07	0.00	0.19	0.07	0.13	0.09	1														
[13] Red Brick Universities	-0.04	0.01	-0.04	-0.03	-0.03	0.03	0.06	0.01	-0.02	0.01	0.01	0.35	1													
[14] Group 1994	-0.04	0.00	-0.02	0.05	-0.05	-0.04	-0.01	-0.08	-0.06	-0.04	0.05	-0.66	-0.23	1												
[15] New Universities	0.01	-0.02	0.00	0.03	-0.03	0.02	0.06	-0.03	-0.02	-0.04	-0.09	-0.18	-0.06	-0.07	1											
[16] Dept. industry funds	-0.04	0.07	0.07	0.04	0.06	0.07	0.03	0.06	0.09	0.23	0.24	0.25	0.09	-0.11	-0.08	1										
[17] Dept. research quality	-0.01	0.00	0.00	0.03	0.13	0.01	0.02	0.16	0.10	0.07	-0.20	0.46	0.12	-0.16	-0.22	0.15	1									
[18] Univ. Patents	0.05	-0.02	-0.02	-0.01	0.06	0.00	-0.05	0.11	0.02	0.02	0.00	0.24	-0.22	-0.25	-0.03	0.14	0.18	1								
[19] Univ. industry funds	0.04	0.01	0.01	0.08	0.05	-0.05	0.03	0.03	0.04	-0.02	-0.12	-0.04	-0.15	-0.12	-0.05	0.07	0.07	0.49	1							
[20] Univ. research quality	-0.02	0.04	0.01	-0.05	0.16	0.05	-0.03	0.29	0.05	0.13	0.14	0.60	0.01	-0.09	-0.42	0.24	0.61	0.32	0.05	1						
[21] Region GDP	0.10	-0.03	0.00	-0.04	0.04	0.05	-0.05	0.14	0.00	-0.04	0.05	0.18	-0.22	-0.13	-0.03	0.05	0.08	0.62	0.25	0.32	1					
[22] Region R&D	-0.01	0.03	0.02	0.05	0.09	-0.02	0.03	0.09	0.06	0.09	-0.06	-0.06	-0.20	0.05	-0.05	-0.01	0.15	-0.19	0.31	0.18	-0.24	1				
[23] Region patents	0.03	0.03	0.02	-0.04	0.11	0.05	-0.01	0.23	0.04	0.10	0.11	0.27	-0.23	0.00	-0.06	0.05	0.31	0.19	0.05	0.60	0.42	0.48	1			
[24] Peers' engagement	-0.02	0.09	0.27	0.11	0.06	0.00	0.10	-0.05	0.08	0.11	-0.25	-0.06	0.00	-0.02	0.00	0.09	0.03	0.01	0.22	-0.09	-0.07	0.08	-0.09	1		
[25] Outside peers' engagement	0.01	-0.08	-0.30	0.07	-0.04	0.00	0.06	-0.07	-0.06	-0.07	-0.22	-0.13	-0.04	-0.01	0.08	0.04	-0.04	0.06	0.21	-0.13	-0.02	0.03	-0.10	0.10	1	
[26] Peers' academic age	-0.10	0.43	0.65	0.03	0.14	0.06	0.06	0.02	0.13	0.22	0.04	0.04	0.02	-0.03	0.03	0.05	-0.04	-0.05	-0.01	0.01	0.00	0.01	0.06	0.16	-0.11	1

Table 6: Regression results for individual industrial engagement

VARIABLES	(1)	(2)	(3)	(4)	(5)
Gender	-0.0381	-0.0428	-0.0375	-0.0360	-0.0322
	(0.044)	(0.042)	(0.043)	(0.045)	(0.045)
Academic age	-0.0073**	-0.0061*	-0.0060**	0.0008	0.0003
	(0.002)	(0.002)	(0.002)	(0.003)	(0.003)
Academic rank	0.2360***	0.1296**	0.1304**	0.1206**	0.1219**
	(0.041)	(0.035)	(0.035)	(0.033)	(0.033)
Industry experience	0.0242***	0.0231***	0.0324***	0.0233***	0.0309***
	(0.004)	(0.004)	(0.007)	(0.004)	(0.007)
Intrinsic motivation	0.0968**	0.0934**	0.0911**	0.0936**	0.0917**
	(0.028)	(0.027)	(0.026)	(0.027)	(0.026)
British PhD	0.2217**	0.1936*	0.1905*	0.1887*	0.1865*
	(0.070)	(0.069)	(0.071)	(0.069)	(0.070)
Elite PhD	-0.0719	-0.0691+	-0.0660+	-0.0674+	-0.0649+
	(0.048)	(0.039)	(0.037)	(0.036)	(0.035)
Star	-0.0946	-0.0806	-0.0800	0.0234	0.0213
	(0.089)	(0.088)	(0.090)	(0.127)	(0.131)
Individual grants	0.0142	0.0130	0.0128	0.0126	0.0125
	(0.018)	(0.016)	(0.016)	(0.017)	(0.017)
Publications	0.0033*	0.0030*	0.0029*	0.0030*	0.0029*
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Basic discipline	-0.3231*	-0.2386*	-0.2362*	-0.2395*	-0.2375*
	(0.135)	(0.096)	(0.094)	(0.097)	(0.095)
Department industry funds (per employee)	0.0000	0.0000	0.0000	0.0000	0.0000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Dept. research quality	0.1324	0.0777	0.0674	0.0743	0.0659
	(0.270)	(0.179)	(0.180)	(0.176)	(0.177)
University patents	0.0380	0.0683	0.0634	0.0631	0.0596
	(0.126)	(0.104)	(0.104)	(0.105)	(0.105)
University industry funds (per employee)	0.0037*	0.0020	0.0021	0.0020	0.0021
	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)
Univ. research quality	-0.4457+	-0.3577*	-0.3415*	-0.3712*	-0.3567*
	(0.224)	(0.156)	(0.154)	(0.149)	(0.146)
Region GDP	0.0000	0.0000	0.0000	0.0000	0.0000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Region R&D	0.0151	0.0222	0.0228	0.0195	0.0202
	(0.051)	(0.042)	(0.042)	(0.042)	(0.042)
Region patents	-0.0002	-0.0003	-0.0003	-0.0003	-0.0003
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Peers' engagement		0.0554***	0.0623***	0.0915***	0.0945***
		(0.010)	(0.012)	(0.014)	(0.015)
Academic age * Peers' engagement				-0.0015**	-0.0014**
				(0.000)	(0.000)
Star * Peers' engagement				-0.0207+	-0.0202+
				(0.013)	(0.015)
Industry experience * Peers' engagement			-0.0019*		-0.0016+
			(0.001)		(0.001)
Constant	1.8112**	1.4480**	1.3908**	1.3348**	1.2962**
	(0.502)	(0.352)	(0.346)	(0.364)	(0.362)
Observations	1,371	1,371	1,371	1,371	1,371
R-squared	0.195	0.242	0.244	0.247	0.248

Notes: Ordinary Least Squares, robust standard errors clustered by discipline. University groups included. One-tailed test for main variables, two-tailed tests for control. $^{+}p<0.10$, $*p<0.05$, $**p<0.01$, $***p<0.001$

Table 7: Regression results for tests for the identification problems

VARIABLES	(1)	(2)	(3)	(4)	(5)
Gender	-0.0428	-0.05	-0.04	-0.05	0.11
	(0.042)	(0.039)	(0.043)	(0.042)	(0.256)
Academic rank	0.1296**	0.14**	0.13**	0.14***	-0.22
	(0.035)	(0.034)	(0.038)	(0.034)	(0.325)
Academic age	-0.0061*	-0.01*	-0.01*	-0.01**	0.02+
	(0.002)	(0.002)	(0.002)	(0.002)	(0.011)
Industry experience	0.0231***	0.02***	0.02***	0.02***	0.00
	(0.004)	(0.003)	(0.004)	(0.004)	(0.024)
Intrinsic motivation	0.0934**	0.09**	0.09**	0.09**	0.14
	(0.027)	(0.023)	(0.027)	(0.027)	(0.128)
British PhD	0.1936*	0.18*	0.19*	0.19*	0.17
	(0.069)	(0.067)	(0.069)	(0.069)	(0.245)
Elite PhD	-0.0691+	-0.04	-0.07+	-0.06	0.28+
	(0.039)	(0.035)	(0.038)	(0.039)	(0.145)
Star	-0.0806	-0.09	-0.08	-0.07	0.15
	(0.088)	(0.084)	(0.088)	(0.086)	(0.344)
Individual grants	0.0130	0.01	0.01	0.01	0.04
	(0.016)	(0.016)	(0.016)	(0.017)	(0.082)
Publications	0.0030*	0.00*	0.00*	0.00*	-0.00
	(0.001)	(0.001)	(0.001)	(0.001)	(0.006)
Basic discipline	-0.2386*	-0.22*	-0.24*	-0.21*	-0.35*
	(0.096)	(0.086)	(0.096)	(0.088)	(0.152)
Department industry funds (per employee)	0.0000	0.00	0.00	0.00	0.00**
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Dept. research quality	0.0777	-0.04	0.08	0.11	-0.91
	(0.179)	(0.170)	(0.182)	(0.163)	(0.904)
University patents	0.0683	0.08	0.07	0.06	0.05
	(0.104)	(0.107)	(0.105)	(0.106)	(0.865)
University industry funds (per employee)	0.0020	0.00	0.00	0.00+	-0.00
	(0.001)	(0.001)	(0.001)	(0.001)	(0.019)
Univ. research quality	-0.3577*	-0.38*	-0.36*	-0.31+	-0.85
	(0.156)	(0.131)	(0.157)	(0.156)	(1.469)
Region GDP	0.0000	0.00	0.00	0.00	0.00+
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Region R&D	0.0222	0.01	0.02	0.02	0.38
	(0.042)	(0.040)	(0.042)	(0.042)	(0.228)
Region patents	-0.0003	-0.00	-0.00	-0.00	-0.01*
	(0.001)	(0.001)	(0.001)	(0.001)	(0.003)
Peers' engagement	0.0554***	0.06***	0.06***	0.05***	0.13*
	(0.010)	(0.011)	(0.010)	(0.010)	(0.045)
Outside peers' engagement		0.01			
		(0.008)			
Peers' academic age			-0.00		
			(0.002)		
Peers' perceptions of benefits				0.02*	
				(0.008)	
Constant	1.4480**	1.52***	1.45**	1.21**	1.55
	(0.352)	(0.245)	(0.346)	(0.370)	(3.316)
Observations	1,371	1,229	1,371	1,371	52
R-squared	0.242	0.241	0.242	0.247	0.672

Notes: Ordinary Least Squares, robust standard errors clustered by discipline. University groups included. Two-tailed tests. $^{+}$*p<0.10, *p<0.05, **p<0.01, ***p<0.001*