Paper to be presented at the DRUID-DIME Academy Winter 2010 PhD Conference

on

Comwell Rebild Bakker, Aalborg, Denmark, January 21 - 23, 2010

COME ENGAGE WITH ME: THE ROLE OF BEHAVIORAL AND ATTITUDINAL COHORT EFFECTS ON ACADEMICS' LEVELS OF ENGAGEMENT WITH INDUSTRY

Valentina Tartari
Imperial College Business School
v.tartari@imperial.ac.uk

Abstract:
Stars in Their Eyes: the Impact of Group, Institutional and Discipline Norms on Academic Researchers Collaboration with Industry

Valentina Tartari, Imperial College Business School, 2008 2011 (exp), v.tartari@imperial.ac.uk

The decision to engage with industry remains an area of discretion for most academics: however, university researchers face strong group, institutional and discipline-based norms to behave in a way which is consistent with their environment. These pressures come from different levels from their immediate peers, from their university, and from colleagues in their wider epistemic community. They also differ in nature. Group pressures arise from the desire to conform to norms and standards held in high regard within a group. Institutional pressures arise from the desire or obligation to conform to formal policies in order to ensure career advancement and sustainability, whereas pressure from the epistemic community is related to the need to share common values and attitudes towards the generation and distribution of knowledge. Moreover, the presence in the department of a star scientist with industrial collaboration activities may increase the likelihood of other researchers in the same department to also collaborate with private firms: stars can be seen as norm-givers and therefore they are able to shape their department s attitudes and hiring behaviours.

To explore the impact of these different levels of pressure on academics collaboration activities with industrial partners, information is drawn from a rich dataset which includes two large-scale overlapping surveys of UK academics. The first round of the survey has been conducted in 2004 by D Este and Patel, while the second round of the survey has been conducted in the second half of 2009: 773 individuals answered both questionnaires. Each respondent has been linked to information gathered from additional datasets: Research Assessment Exercises (RAE) 2008 scores, data on universities funding sources collected by the Higher Education Funding Council for England (HEFCE), data on grants awarded by the Engineering and Physical Sciences Research Council (EPSRC) in the last 10 years (including grants awarded in partnership with private companies), ISIHighlyCited.com and data on scientific prizes and affiliation with prestigious societies, such as the Royal Society. Groups have been constructed based on the department affiliation, while epistemic communities comprise individuals listed in the same units of assessment of the RAE. Stars scientists have been identified as highly funded scientists (in the top 90th percentile of funding received), highly cited researchers (listed in ISIHighlyCited.com), recipients of scientific prizes (such as the Nobel Prize) or members of prestigious scientific societies. Data on collaboration activities have been extracted from the questionnaire: interactions are divided into several categories and respondents provided the frequency of engagement in each category of interaction during the

JEL - codes: O31, -, -

COME ENGAGE WITH ME:
The Role of Behavioral and Attitudinal Cohort Effects on Academics' Levels of Engagement with Industry

Valentina Tartari

With Ammon Salter, Pablo D'Este and Markus Perkmann

Abstract
Although academics have considerable autonomy, they work in a highly institutionalized environment and are subject to social expectations and pressures from a range of domains, including their colleagues, their department leadership, their university and members of their discipline. Recent efforts to understand how the behavior of an academic's peers shapes the nature of academic's engagement with industry have suggested that there are strong cohort effects, in that the entrepreneurial behavior of one's colleagues in the same department will encourage academics to become entrepreneurs themselves. This study builds on and extends this work by exploring how both the behaviors *and* attitudes of colleagues shape an academic's engagement with industry. In doing so, it separates out the effects of what local peers do from what they think about industry engagement in order to gain better understanding the nature of the social processes that shape an academic's decision to engage with industry. The analysis builds on a set of rich datasets that cover the industrial engagements of large sample of UK academics from physical and engineering sciences. The paper argues - and empirically demonstrates - that both behavioral and attitudinal cohort effects shape individual engagement behavior and attitudes, yet behavioral effects have a stronger impact than attitudinal effects. It explores the implications of these findings our understanding of cohort effects in professional organizations and for policies designed to encourage academics to engage with industry.

Keywords: academic entrepreneurship, university-industry interactions, academic engagement; channels of engagement

Introduction

Academic life presents many opportunities and responsibilities. Academics have considerable autonomy, with a significant portion of their time set aside for their own research. At the same time, they are subject to a high-powered incentive regime, with strong rewards for success and severe punishments for failure. Furthermore, academics work in collegial organizations, with little formal structure and highly decentralized decision-making. Building successful and productive relationships with one's colleagues can be a critical part of an academic's professional life. Such relationships may allow an academic to attract resources or support from their colleagues for their personal research efforts.

To be sure, academic life is rife with competition between local colleagues and colleagues located at other universities. Many academics are fiercely competitive, seeking to gain advantage and standing over their peers in the hope that they may be recognized as leaders in their wider epistemic community. As such, they may engage in 'status competitions' (Lazega 2001) with their peers hoping that by publishing first and in higher prestige journals; by winning research grants and prizes; by recruiting, training and then placing their students at top universities, they will be able to forward their reputation in the community. Alongside these competitive elements, academia is characterized by the wider values of science, such as openness, skepticism, objectivity and communalism (Merton 1973). These scientific norms are seen to bind academics to the wider epistemic community, holding common norms about how knowledge is created and exchanged (Knorr Certina 1999). Such norms are central to many scientists' notion of the public place of their profession and upheld as part of the virtue of the scientific enterprise in comparison to private enterprise.

In recent years, academics have come under increasing pressure to engage with industry (Jensen and Thursby 2001). These pressures have arisen from the desire of governments to encourage universities to act as 'motors of economic development' (Etzkowitz, Webster et al. 2000). Such engagement can take many forms, including undertaking joint research, performing consultancy for private firms, integrating teaching with industrial requirements or even starting up a firm or taking out a patent (Agrawal and Henderson 2002; D'Este and Patel 2007). In many respects, these engagements are not new. Indeed, also in the past most academics used to engage with industry in some form or another as the majority of university researchers work in fairly applied fields, such as medicine and engineering (Nelson and Rosenberg 1994). Moreover, problems in industry have long acted as a powerful stimulus for the development of more basic and applied science (Rosenberg 1982). Yet over the past three decades, governments have increasing encouraged or even required universities to be 'entrepreneurial' and to enhance their engagement with industry. For example, in the UK, part of universities funding is now tied to the evidence of engagement in 'third stream' activities, defined in this instance as patents, licenses and industry-financed contract research (Chapple, Lockett et al. 2005).

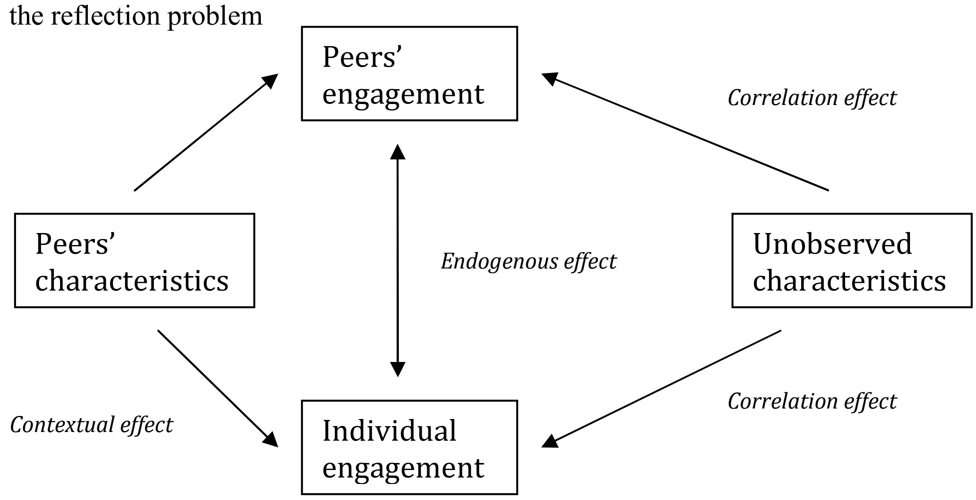
A vast research effort in management and economics has sought to explain why academics engage in entrepreneurial activities and what are the consequences this engagement has for academic productivity. This first generation of research in this area tended to focus on the individual's structural characteristics, such as age, gender and rank, or on the broad institutional factors that are liable to shape engagement choices, such as the discipline or the research quality of department or university of the researcher (Rothaermel, Agung et al. 2007). However, recent research in this tradition has begun to unpack the social factors that underpin the decision to engage with industry by an academic. In particular, research has shown that academic entrepreneurship is strongly influenced by the behavior of the departmental colleagues. Using a sample of US life scientists, Stuart and Ding (2006) found that the greater number of department colleagues that were involved in private sector firms, the higher the likelihood of an individual academic in the same department would also be involved in an industrial firm. These effects were stronger if one was based in an applied area of science, if one of your colleagues that was involved in a business was of high status, and if one's co-authors were also involved in industrial practice. A related study by Bercovitz and Feldman (2008) of medical researchers at John Hopkins and Duke, focused on three types of effects – training, leadership and cohort. This study found that if an academic was trained at an institution with a tradition of academic entrepreneurship and had a departmental chair who was entrepreneurial, they were more likely to be entrepreneurial themselves. They also found that there are local cohort effects, in that if colleagues of the same rank in the same department were entrepreneurial then academics were more likely to engage in entrepreneurship activities.

This study attempts to build and extend these two studies in three important ways. First, engagement with industry can mean many different things to an academic. In previous research, researchers have tended to focus on 'academic entrepreneurship' – defined as variously as filing invention disclosures, patenting or being involved in a private company. However, these types of academic entrepreneurship – even among leading universities – are relatively rare events. For example, it has been estimated that patents and licensing represent only around 6-11% of the information transferred out from university (Agrawal and Henderson 2002). Moreover, such activities are extreme forms of engagement and many academics engage with industry, but without being involved in a private firm or taking out a patent. In this study, we focus on broader and more common forms of academics' engagements with industry including consulting, contract research, joint research projects and training of company employees. In doing so, it may be possible to develop a clearer perspective on the social forces that drive cohort effects on industry engagement among the wider share of academics.

Second, previous studies have tended to focus in academic entrepreneurship in the life sciences (or among medical researchers). Life-sciences is a field of research that in recent years has been characterized by strong science-industry linkages: ideas developed into science can be effectively appropriated by formal means, such as patents, and science can be transferred into practice, via biotechnology firms or through the market for technology (Powell, Koput et al. 1996). However, as many commentators on university-industry linkages have reminded us, this field may be atypical of the wider range of interactions between universities and industry, and it would be unwise to generalize from patterns in this area to the rest of the academic sector, as it appears to differ so significantly from more conventional interactions between universities and industry in other domains (Nelson 2004). To this end, we focus on a wide range of disciplines, including basic fields of science such as mathematics and more applied areas of engineering, such as mechanical or civil engineering.

The third and perhaps the most significant challenge we face is common to all studies of the cohort effect on academic entrepreneurship and it is what Manski (1993; 2000) has called the 'reflection problem'. This problem states that evidence for peer effects in social science is liable to be over stated in studies where the average behavior of a group is used to explain individual behavior. The problem here is three-fold. First, there may be endogenous factors that explain why individual is selected into a group. Second, a correlation effect may exist because of unobservable characteristics which influence both the behavior of the individual and of his peers. Third, there are exogenous (contextual) effects: the propensity of an individual to behave in some way changes with the exogenous characteristics of his/ her peers. The three effects are represented in figure 1.

Figure 1: the reflection problem



As Stuart and Ding (2006) and Bercovitz and Feldman (2008) suggest it is very difficult to deal with this problem in studies of academic behavior as there are few aspects of academic life that are truly exogenous. Stuart and Ding propose to exclude the endogenous matching issue by selecting individuals trained in the "pre-commercialization period" (they take as a reference year the foundation of Genentech) who since then never hanged institution. Bercovitz and Feldman treat the selection problem with a two-fold strategy. First, they check that there was no statistically significant difference in the likelihood that an individual with dual degree (used as a proxy for being more inclined by training to disclosing) would be hire into a department whose chair actively participated in technology transfer, versus a department with a chair who did not disclose. Moreover, they adopted an approach similar to Suart and Ding and performed a sample split on the researchers hired before the Bayh-Dole Act, in a period where technology transfer was less common as an institutionalized procedure in universities. They also addressed the concerns about the effect of unobserved heterogeneity, running a model which includes a variable that measures the behavior of colleagues outside the reference peer group, finding no significant effect.

Our approach to the 'reflection problem' builds on the suggestion made by Manski (1993) that researchers should focus on 'subjective' measures of peer effects - that is, information taken directly from the subjects themselves. According to Manski, this information is less likely to be tainted by the 'reflection problem' as it is not easily observable by others. Moreover, Manski suggests that social scientists would gain by focusing on attitudes and perceptions as well as behavior in the study of peer effects as these attitudes and perceptions may be the real mechanism through which peer effects occur. Building on this suggestion, our study looks not only at the effects of cohort behavior on individual academic's engagement efforts, consistently with Stuart and Ding (2006) and Bercovitz and Feldman (2008); yet, we go beyond this approach as we also look at attitudinal cohort effects. We are interested in how the perceptions and attitudes of one's colleagues towards engagement shape an individual's engagement behavior and attitudes. This approach has the advantage of moving away from 'behavior only' tests of peer effects, which may be subject to a range of difficult identification issues. This approach also allows us to see how behavior and attitudes to industrial engagement interplay, and whether attitudes and behavior jointly shape an individual's behavior and attitudes to industrial engagement.

The analysis of these questions is undertaken on the basis of a rich sample of UK academics, mainly from the physical and engineering sciences. We combine data from multiple sources, including a large-scale survey, the records of the UK largest research council as well as information on departments and universities from public records. We explore how the level of engagement of individual academics is shaped by their cohort's behavior and attitudes. We begin the analysis by explore local cohort effects on individual behavior. We then extend this analysis to look at impact of attitudes of the local cohort towards the benefits and barriers of working with industry on an individual's own perception of the benefits and barriers of working with industry. Finally, we explore whether the cohort's behavior or attitudes more powerfully influence individual's behavior and perceptions of working with industry.

Hypotheses development

The department is one of the central organizational features of academic life. Although departments are often broken down into smaller administrative units and within these sub-groups, there are still smaller research teams, the department remains the location of much of organizational decision-making in academe. Working in a department imposes obligations and responsibilities on academic staff. These include sharing teaching workloads, sitting on departmental committees and the like. Hiring, promotion and tenure applications are normally decided upon at the department level before being considered by the wider university. Departments also differ even within the same university about expectations of scholarship and citizenship behavior. Some departments have close knit and overlapping bounds of collegiality, whereas others are simply hosting arrangements for a diverse collection of individuals with common teaching responsibilities.

Departments often play an important role in shaping the pattern of working behavior and norms about performative aspects of academic life (Feldman 2000). Departmental colleagues are usually proximate to the individual and their behavior may be easily observed. In addition, academics are liable to benchmark their performance against their colleagues of similar rank in the same department, helping to set their own professional performance expectations, such as the numbers and types of publications or scores on teaching evaluations. Many critical human resource decisions within an academic department are based on local cohort comparisons, such as tenure decisions or yearly performance appraisals. To be sure, there are often fierce rivalries within department between individuals. Academic politics - famously described by Henry Kissinger as worse than real world politics – can be highly fracturous and contentious. These political conflicts help to expose different modes of working and importance of status within a community with shared norms and strong mutual behavioral pressures. It also reflects the autonomous nature of academic work, with usually requires individuals to be judged on their own accomplishments. In this environment, individuals may lack empathy for their colleagues and see themselves as engaged in zero-sum games for power, status and resources.

Like many professionals, academics also rely on their local colleagues to help them solve problems (Becher 1989; Becher 1999). Turning to colleagues within your local environment may provide opportunities to learn about different areas of science and to apply lessons of one person's research to your own. Network studies of academics have shown that there are often strong bonds of reciprocity within an academic department, although most academics rely on contacts outside their department more than their local colleagues to solve problems (Crane 1969; Friedkin 1978). Local colleagues may also be helpful in terms of gaining support and validation for new ideas. Novel ideas in science or engineering often need early support to be nurtured and examined, and local colleagues can provide early signals about the potential scientific value of a new idea. Since many of these early ideas can only be expressed incompletely, face-to-face communication with trusted local colleagues usually provides a low-cost and efficient mechanism to assess the value and viability of an early stage scientific intuition.

Departmental colleagues may also help to set expectations about engagement with industry. In some departments with strong ties to private companies, engagement with industry may be expected norm of all staff; whereas in basic research oriented departments, engagement with industry may be deviant from social norms. Because departmental colleagues behavior may be observable, it is possible to learn about expected norms in terms of industry engagement. In doing so, department's colleagues' engagement efforts may play a positive role in shaping the behavior of others within a department. However, this effect is likely only to hold for colleagues of same rank as this group represents the reference group for the individual, and helps set the department's norms and expectations in terms of behavior for a person of the same rank. Thus,

H1. The degree of an academic's engagement with industry will be positively associated with the level of industry engagement of their local peer cohort

As we have seen, attempting to estimate cohort effects on individuals is complicated by the reflection problem. The influence of average group behaviour on an individual's behaviour may reflect unmeasured factors, leading to the systematic over-reporting of peer effects in social science. Yet attitudes and perceptions appear less likely to susceptible to such measurement errors as they are less visible and therefore offer a poorer reflection of the individual within the group (Manski, 1993; 2000).

Two sets of group attitudes may be relevant for determining academic's decision to engage with industry: perceptions towards the benefits of collaboration and the barriers to collaboration. Perceptions of the benefits of collaboration reflect individual's views about the positive nature of engagement and what impact it has one their own research efforts. It speaks to an academic's personal experience of engagement as well as their more general views about the benefits of industrial engagement. Some of the benefits that academic perceive from working with industry may be related to their own personal research agendas, including gaining access to critical resources such as equipment or funding. Other benefits concern the framing of research questions or keeping abreast of problems industry is facing, as industrial problems may provide a stimulus for further scientific research. Engagement may also enable researchers to find employment for their students and research staff. The scope of these benefits perceived by an academic reflects the breath of opportunities they see from engagement with industry and speaks to an academic's level of enthusiasm for industrial engagement.

In contrast, the level of barriers to industry engagement perceived by an academic attests to the difficulties and challenges of working across the institutional divide between private enterprise and public science. These barriers are normally related to orientation differences between industrial and academic researchers (Dasgupta and David 1994). Academic researchers are liable to want to undertake long-term research projects and set their own research agendas, focusing on issues that are likely to lead to publications in top-tier journals. In contrast, industrial researchers may be looking for short-term projects, focused around the delivery of specific requirement or need. In addition, conflicts may arise between academics and their industrial partners about the timing of the disclosure of research results, and about the ownership and use of the intellectual property arising out of a research project (Shane 2004). These conflicts not only involve distributional conflicts between the academic and her/his industrial partners about the research results, but also between the university and its Technology Transfer Office (TTO) and the industrial partner (Shane and Somaya 2007). As universities become more and more interested in retaining IPRs over their research, such conflicts are becoming widespread and can slow down the research process, turning some academics away from industrial engagement altogether.

Both the perceptions of benefits and barriers among an academic's local peers may have strong effect on the engagement behaviour of an academic. If an academic's local peers perceive strong benefits to collaborate with industry, they are liable to offer proactive support to their colleagues engaging in collaboration, offering support and advice to enable them to successfully engage. In addition, perceptions about the benefits of collaboration among a set of peers may also be reflected in departmental decision-making and allocation of resources towards such engagement efforts. If one's peers perceive little benefit from collaboration, then attempts to engage with industrial partners may face negative pressures. In this environment, positive engagement attitudes may be seen as deviant from the group's norms and lead to sanctions such as being ostracized from the group. The same patterns may be in place for perceived barriers as negative perceptions are likely to send strong signals within a group. These factors suggest that cohort effects may be present for attitudes as the positive and negative attitudes of one's local peers may in turn shape an individual's attitudes to engagement. Thus,

H2a. The breadth of benefits that an individual perceives from engaging with industry will be positively associated with the breadth of benefits perceived by their local peer cohort.

H2b. The breadth of barriers that an individual perceives from engaging with industry will be positively associated with the breadth of barriers perceived by their local peer cohort.

Such collective perceptions may not only shape an individual's perception of benefits and barriers of industry engagement, they may shape an individual's engagement behaviour as well. Positive local attitudes may increase the willingness of individual's to engage, even in environments were the overall level of industry engagement is low. This is because although the level of actual engagement is modest, local peers themselves perceive benefits from engagement, thus contributing to create a supportive culture for engagement. In environments where engagement is more common but individuals perceive little or no benefits to engagement, it may be difficult for an individual to sustain broad engagement efforts with industry. The effects are likely to be similar for the perceived barriers as they represent negative attitudes and such negative views towards engagement may deter others from engaging themselves. Thus,

H2c. *The level of an individual's engagement with industry will be positively associated with the breadth of benefits perceived by their local peer cohort.*

H2d. The level of an individual's engagement with industry will be negatively associated with the breadth of barriers perceived by their local peer cohort.

The proceeding discussion contrasts the effects of local cohort's behavior or attitudes on individual's engagement attitudes and behavior. However, this approach does not speak to the question of what matters more to the engagement behavior of the individual – the attitudes or the behavior of their local peer cohort. There are two strong reasons to suggest that behaviour matters more than attitudes in terms of shaping an academic's engagement behaviour. First, the 'observability' of attitudes is lower than behaviour. To obtain another person's opinion about something important, it usually requires that they be asked directly. The willingness of a person to share their perceptions about something in the workplace with colleague is often a function of the degree of trust and reciprocity between those two individuals. This is likely to be especially the case when these attitudes deviate from the group's norms or expectations. Second, although there may strong pressures within a group to conform to certain types of behaviour, individuals whose attitudes differ from the group may be able to maintain such divergent opinions as long as they conform to the group's behavioural norm. These divergent attitudes may be kept silent or only shared with trusted colleagues. To be sure, organizations may be willing to tolerate divergent opinions as long as their behavioural expectation is met. In this sense, attitudes are likely to matter less than behaviour in terms of shaping individual's engagement efforts as they may be unobserved or stated only among close confidents. Thus,

H3. The effect of local cohort's behaviour towards industry on an individual's levels of engagement with industry will be greater than the effects of their local cohort's attitudes to engagement

Data and methodology

In this paper, our aim is to explore to what extent academics' external engagement is explained by their peers' external engagement activities and attitudes towards collaboration with industry. In order to do so, we draw information from several sources, providing both primary and secondary data.

First of all, we use information from a questionnaire administered to 6200 academic researchers in the United Kingdom. The sample of researchers to investigate has been obtained 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 funding body for research in the UK (it distributed £740 million of research funding in 2008) and funds research in all fields of engineering, mathematics, chemistry, and physics. The EPSRC encourages partnerships between researchers and third parties, such as private firms, government agencies, local authorities, non-profit organizations etc. Therefore, in the grant portfolio we can observe a mixture of collaborative (involving industrial or non-industrial partners) and response mode grants. The questionnaire has been administered electronically between April and September 2009: the invitation to participate in the survey was included in a letter of endorsement sent by the Chief Executive of the EPSRC. An email containing a personalized link to access the survey was sent few days later, followed by two emails and a telephone reminder to non-respondents. This yielded to a total of 2194 completed questionnaires, for a response rate of 36%.

The survey was designed to capture university researchers' attitudes to collaboration with industry. We collected information about actual engagement patterns and attitudes towards collaboration. We tested the clarity of the questionnaire through a pilot study conducted at Imperial College with 30 academics in 10 different departments. We sent an invitation to complete the questionnaire online and we then followed up by phone both respondents and non-respondents to ask their opinions about the general impression about the questionnaire and about both the phrasing and the content of the questions, in order to check for possible ambiguities. We also asked the respondents how long it took to complete the questionnaire. In this test phase, no major inconsistencies emerged.

We then proceeded to merge the information obtained through the survey with several sources of secondary data. For every academic in the sample we collected information about the details of the grants they have been awarded by the EPSRC. In particular, we have details on the amount of funding received, the duration of the projects and the names of the third parties involved (if any).

We subsequently matched our sample with the population of academics included in the Research Assessment Exercise (RAE) conducted in 2008. The RAE assesses the quality of research in universities and colleges in the UK: 2,344 submissions were made by 159 Higher Education Institutions in 2008 (covering the period 2001-2007). The RAE is conducted jointly by the Higher Education Funding Council for England, the Scottish Funding Council, the Higher Education Funding Council for Wales and the Department for Employment and Learning of Northern Ireland: these bodies intend to use the quality profiles obtained to determine the amount of grants given to the institutions they fund. We were able to assign individuals in our sample to the unit of assessment they belonged in the RAE, obtaining additional information about the size of the unit of assessment, the amount and nature of funding received in the last seven years, the quality of the research performed in their department.

We then matched the universities included in our sample with data collected by the Higher Education Funding Council for England (HEFCE) through the Higher education-business and community interaction survey (HE-BCI) conducted in 2008 (covering the years 2005-2007). The annual HE-BCI survey examines the exchange of knowledge between universities and the society in a wider sense: it collects financial and output data per academic year at university level on a range of activities, from the commercialization of new knowledge, through the delivery of professional training, consultancy and services, to activities intended to have direct social benefits.

We also matched our population with the lists of members of the Royal Society of Sciences and the Royal Academy of Engineering. The Royal Society is the oldest scientific academy (it has been founded in 1660) and it awards each year fellowships to 44 of the best scientists in recognition of their scientific achievements (there are currently 1400 Fellows of which 60 are Nobel laureates). The Royal Academy of Engineers include UK's most eminent engineers: each year up to 60 Fellows are elected from nominations made by the existing Fellows (there are currently 1426 Fellows). Furthermore, we checked if the academics in our population were included in ISIHighlyCited.com. This database contains the 250 most cited researchers in 21 broad subject categories in life sciences, medicine, physical sciences, engineering and social sciences, comprising less than one-half of one percent of all publishing researchers and therefore highlighting truly outstanding scientific contributions.

Finally, we have identified the regions (NUTS2 level) in which the universities in our sample are located and we linked the regions with data about their economic and innovative performance (gross domestic product, research and development expenses of the business sector, patent applications) collected by Eurostat in 2003.

After having completed the matching process we are left with 1895 usable questionnaires.

Dependent variables

In order to understand the effect of peers on the external engagement of academics, we have specified three different models. The main model's dependent variable captures the engagement behavior of academics through the construction of a scale of external involvement. The individual *industrial involvement* scale (IIS) is a modified version of the scale developed by Bozeman and Gaughan in 2007. Through the survey, we collected information on the variety and frequency of interactions of researchers with industry. The items used to construct the scale are reported in table 1.

Table 1: types of researchers' interaction with industry

1. Creation of new physical facilities with industry funding (e.g. new laboratory, other buildings on campus)
2. A new joint research agreement (original research work undertaken by both partners)
3. A new contract research agreement (original research work done by University alone)
4. A new consultancy agreement (provision of advice that requires no original research)
5. Training of company employees (through course enrolment or through temporary personnel exchanges)
6. Postgraduate training with a company (e.g. joint supervision of PhDs)
7. Attendance at conferences with industry and university participation
8. Attendance at industry sponsored meetings

We first examined the percentages for each industrial interaction item (answers coded as dummies yes/no) and we used the inverse of these frequencies as weights. We then multiplied the actual number of interactions declared by each academic for each channel to its weight. All these scores have then been summed, creating a weighted industrial involvement scale. With this construction we take into account the “difficulty” (and rareness) of certain items (such as the creation of new physical facilities) relatively to others (such as attending industry sponsored meetings). The reliability of this scale was estimated using Cronbach’s Alpha measure which demonstrates how well a set of items (or variables) measures a single one-dimensional latent construct (reliability coefficient for indexes). Cronbach’s Alpha for the individual industrial involvement scale is 0.8, which is widely accepted as a good reliability score. In order to apply an ordinary least squares (OLS) model, in the analysis we use the natural logarithm of the variable.

The two additional models seek to explain the individual attitudes towards engagement as a function of the peers’ attitudes. We therefore constructed two variables, one measuring positive attitudes towards engagement and one measuring negative attitudes towards engagement. The first variable quantifies the breadth of perceived *benefits* from interaction as the total number of benefits that an individual indicates to receive from working with industry on the survey as being ‘important’ or ‘very important’(items used are reported in table 2).

Table 2: researchers’ motivations for engaging with industry

1. Source of personal income
2. Source of additional research income
3. Keeping abreast of research conducted in industry
4. Raising awareness of problems that industry confronts
5. Building and sustaining your professional network
6. Seeking proprietary knowledge (e.g. patents)
7. Increasing the likelihood of application of my research outside academia
8. Feedback from industry about viability of research
9. Access to materials or data necessary for research
10. Access to research expertise of industry employees
11. Access to state-of-the art equipment, facilities and instruments
12. Helping students to find employment in industry
13. Improving the understanding of foundations of particular phenomena
14. Training of postgraduate students
15. Getting inspiration for new research projects

Similarly, the second variable quantifies the breadth of perceived *barriers* towards interaction as the total number of barriers that an individual indicates to face in working with industry on the survey as being 'important' or 'very important' (12 items). We report items included in the construction of this scale in table 3.

Table 3: barriers towards collaboration with industry as perceived by researchers

1. Absence of established procedures for collaboration with industry
2. University's Technology Transfer Offices have a low profile
3. The nature of my research is not linked with industry interests or needs
4. Potential conflicts with industry regarding Intellectual Property Rights
5. Short term orientation of industry research
6. Lack of suitable government funding programmes for university-industry joint research in specific areas
7. Industry imposes delays in dissemination of research outcomes and publications
8. Rules and regulations imposed by university or government funding agencies
9. Difficulty in finding companies with appropriate profile (e.g. highly innovative partners)
10. Mutual lack of understanding about expectations and working priorities
11. High personnel turnover and lack of continuity in companies' research strategies
12. Policies adopted by the university's Technology Transfer Office

The reliability of these two scales was estimated using Cronbach's Alpha which for perceived benefits is 0.8 and for perceived barriers is 0.7. In order to apply a fractional response regression model, we normalize both variables by dividing by the maximum number of benefits or barriers perceived so that the resulting variables take a minimum value of 0 and a maximum of 1. Summary statistics for the dependent variables are reported in table 4.

Table 4: summary statistics for independent variables

Variable name	*Mean*	*Std Dev*	*Min*	*Max*
Industrial involvement	1.41	0.76	0	3.53
Benefits	0.4	0.24	0	1
Barriers	0.22	0.18	0	1

Independent variables

The independent variables refer to the peers' behaviors and norms about external engagement. We define peers as the other researchers in the department of the same academic rank as the focal individual. We therefore define an independent variable which measures the level of external engagement of the local cohort of academics. The *local cohort engagement* quantifies the average industrial involvement scale of peers excluding the focal individual.

In order to take into account the reflection problem, we follow the suggestion made by Manski (1993) and we include in the regressions subjective measures of peer effects. We therefore construct a measure of the level of local cohort support to collaboration activities with industry: the *local cohort benefits* measures the average number of benefits perceived by peers and the *local cohort barriers* measures the average number of barriers perceived by peers (always excluding the focal individual).

Following concerns about the effect of shared unobservable characteristic of the environment on the individual behavior (Bikhchandani 1992; Manski 1993), we follow the approach adopted by Bercovitz and Feldman (2008) and we include an additional independent variable measuring the engagement behaviors of researchers in the outside cohort, i.e. members of the same department but of different rank. We therefore construct the *outside cohort engagement* as the average industrial involvement scale of peers in the outside cohort. All four independent variables have been standardized in order to make comparisons easier.

Of course, in order to have meaningful measures relative to cohorts' behaviors and attitudes we need to have at least another researcher other than the focal individual of the same rank in the same department. Therefore, after having constructed the local cohorts we are left with 1367 valid observations. If we also take into account the outside cohort, we need an additional individual in the same department but of a different rank: when we include the measure relative to the outside cohort we are thus left with 1214 observations. Summary statistics for the independent variables are reported in table 5.

Table 5: summary statistics for independent variables

Variable name	*Mean*	*Std Dev*	*Min*	*Max*
Local cohort engagement	0	1	-1.33	8.58
Local cohort benefits	0	1	-2.14	3.23
Local cohort barriers	0	1	-1.59	5.79
Outside cohort engagement	0	1	-5.81	8.82

Control variables

We have included in the model several controls at the individual, department, university and regional level to take into account individual and environmental effects which have been previously observed to have an effect on the engagement behaviour of academics.

A first group of control variables relates to the individual characteristics of the academics. We have included a set of demographic characteristics of the researchers such as their *gender* and their *academic rank* (coded as a dummy which identifies the group of professors). Link et al. (2007) find a positive effect of being male and being tenured on collaboration activities with industry; Ponomariov (2007) gets to a similar result for tenure. We also control for training effects including the number of years of work experience in the private sector (*industry experience*), the researchers' *academic age* (defined as their age today minus their age when they have been awarded their PhD), a dummy variable identifying holder of British doctoral degrees (*British PhD*) and a proxy for the quality of the institution where the PhD was awarded (e*lite PhD*), coded as a dummy variable indicating if the institution is part of the Times Higher Education Supplement (2004) list of worldwide top universities. According to Bercovitz and Feldman (2008), the longer the time elapsed from the granting of the PhD degree, the less likely the researchers are to embrace commercialization behaviors. We then control for the quality and productivity of the researchers. We include the total amount of research funds received from EPSRC in the period 2000-2006 standardized by average level of funding in the researchers discipline (*individual grants*). We also incorporate a dummy which identifies star scientists as fellows of the Royal Society or the Royal Academy of Engineering, or as included in the ISIHiglyCited.com (*star*). Several authors find that faculty with industrial support or performing entrepreneurial activities publish at least as much as the rest of faculty or even more (Blumenthal, Campbell et al. 1996; Gulbrandsen and Smeby 2005; Lee and Bozeman 2005), while others fail to identify a clear relationship between collaboration activities and academic productivity (Agrawal and Henderson 2002), or identify an inverse U-shaped relationship claiming that researchers with industrial exposure publish less if their whole career is taken into account (Lin and Bozeman 2006). The scientific discipline of the researchers is taken into account by introducing a dummy variable (*basic discipline*) identifying basic disciplines (mathematics, chemistry, physics). The researchers' scientific fields tend to define the extent of their engagement in collaborative activities with industry: more applied fields of science, such as engineering, make collaboration more likely (Rosenberg and Nelson 1994). Moreover, it has been observed that for researchers working within the so-called Pasteur's Quadrant (Stokes 1997), practical problems provide a powerful stimulus to the development of new ideas (Lee 1996; Landry, Amara et al. 2006; Arvanitis, Kubli et al. 2008).

A second group of variables is related to department characteristics. We have included in the regressions the total income per FTE (full time employee) received in 2005-2007 (*department funds*). We also control for the *department research quality* (measured as the percentage of staff rated 4* and 3* in the RAE 2008) and the *department size* (number of FTEs).

The third group of variables refers to the university level. We control for the institutional involvement in commercialization and collaboration activities including the stock of *university patents* per FTE and the income received from industry per employee in the period 2005-2007 (*university industry funds*). We take into account the profile of the universities in the sample by introducing measures of their quality as the overall RAE 2008 score (*university research quality*), and by incorporating to which *group* (Russell Group, Red Brick, 1994 Group, Ex-Polytechnic) they belong. We also control for the *university size*, as the number of FTEs in research activities. Institutional support seems to have become more and more relevant to foster collaboration between universities and industry and to facilitate the technology transfer process. From the late 80s when researchers considered that personal networking efforts with industry were more effective than institutionalized transfer mechanisms (Louis, Blumenthal et al. 1989; Van Dierdonck, Debackere et al. 1990), we observe now a shared belief that collaboration and entrepreneurial activities are enhanced by the presence of formal support infrastructure and institutional incentive mechanisms (Chrisman, Hynes et al. 1995; Owen-Smith 2001; Landry, Amara et al. 2006; Renault 2006; Yang, Chang et al. 2006; Baldini 2007; Sellenthin 2009), often with a stronger effect at the level of department or research group (Kenney and Richard Goe 2004; Krabel and Mueller 2009). However, we observe that the impact of the overall academic quality of the institution on the likelihood to participate in technology transfer and commercialization activities remains clear: some authors in fact find a positive relationship between academic excellence and participation in technology transfer (Renault 2006; Ambos 2008), while others find a negative relationship (Ponomariov 2008).

Finally, the last group of variables refers to the regional level. We have identified the regions (NUTS2 level) in which the universities in our sample are located and we have included measures relative to their innovative and scientific performance. We include in the regressions the gross domestic product (*region GDP*) of the region (measured in millions of Euro), the expenditures (in millions of Euro) in research and development of the business sector (*region R&D*) and the number of EPO patent applications per million of inhabitants (*region patents*). Spatial characteristics appear o be particularly relevant in defining innovation patterns. As it has been observed that knowledge is generated and transmitted more efficiently via local proximity, economic activities based on new knowledge tend to cluster within a geographical region

(Audretsch 1998). Investment in research and development by private companies, universities and public research organizations can be transferred to neighboring third parties through spillovers (Jaffe 1989; Acs 1992; Acs 1994; Feldman 1994; Breschi and Lissoni 2001), it is therefore important to control for the level of private innovative activity in the region. Summary statistics for control variables are presented in table 6.

Table 6: summary statistics for control variables

Variable name	*Mean*	*Std. Dev.*	*Min*	*Max*
Individual level				
Gender (female=1)	0.12	0.33	0	1
Academic rank (professor=1)	0.44	0.5	0	1
Industry experience	3.01	5.67	0	45
Academic age	21.10	9.93	1	60
British PhD	0.83	0.37	0	1
Elite PhD	0.41	0.49	0	1
Individual grants	1	2.2	0	34.23
Star	0.06	0.24	0	1
Basic discipline	0.41	0.49	0	1
Department level				
Department funds	198700	140234.7	594.94	2035282
Department research quality	0.62	0.15	0.1	0.95
Department size	99.71	1.61	80	100
University level				
University patents	0.25	0.33	0	7.1
University industry funds (£000)	23.31	23	0.37	142.81
University research quality	2.67	0.21	1.23	3.15
University size	1018.58	573.04	26.8	2245.83
Regional level				
Region GDP (Millions of Euro)	72749.66	54912.62	17116.7	193751.9
Region R&D (Millions of Euro)	1.77	0.96	0.93	4.29
Region patents	74.32	57.71	0.07	198.89

Correlations among all the variables are presented in table 7. They are generally low to moderate; therefore multicollinearity is generally not a problem for the estimation.

Table 7: Correlations

Results

Table 8 provides results for the researchers' engagement behaviors and attitudes. Model (1) provides a baseline model with the individual industrial involvement scale as the dependent variable. Being a professor has a positive and statistically significant effect on the level of engagement with industry. This finding, in line with previous research (Link, Siegel et al. 2007; Ponomariov 2008), suggests that as most collaborations start out of personal contacts, it is more likely that more experienced researchers have a larger network to rely on for starting engagement activities with private companies. Work experience in the private sector is also positive and significant: previous experience in industrial settings increases the likelihood of academics' participation in knowledge transfer activities as individuals tend to repeat consolidated behaviors (Landry, Amara et al. 2006; Bozeman and Gaughan 2007; Arvanitis, Kubli et al. 2008; Ponomariov and Craig Boardman 2008; Krabel and Mueller 2009; Sellenthin 2009). Academic age has a negative and statistically significant effect: as observed by Bercovitz and Feldman (2008), the earlier a researcher has completed his training, the less likely he will be to engage in collaboration activities with industry. This training effect takes into account the fact that individuals who have been formed in a period in which universities' engagement with industry was less relevant or even discouraged, have probably developed norms which make more difficult to collaborate with private companies. Moreover, faculty trained in the United Kingdom is significantly more likely to engage with industry than those who have been trained in other countries, while having been awarded the PhD in a top institution does not seem to have any effect. Interestingly, the amount of funding received by the EPSRC is not statistically significant in this estimation, while being a star scientist has a positive and significant effect on engagement. This is consistent with published literature in which it has been reported that being highly productive in academic terms increases the likelihood of being involved in collaboration or commercialization activities (Van Dierdonck, Debackere et al. 1990; Nicolaou and Birley 2003; Ponomariov 2008). Being affiliated with a basic discipline has a negative and significant effect on engagement. As previously noted, the researchers' scientific disciplines indeed define the extent of their engagement in collaborative activities with industry: more applied fields of science, such as engineering, make collaboration or engagement in entrepreneurial activities more likely

(Landry, Amara et al. 2006; D'Este and Patel 2007; Arvanitis, Kubli et al. 2008; Bekkers and Bodas Freitas 2008; Martinelli, Meyer et al. 2008). None of the variables at the department and the regional levels have a significant effect. At the university level, only the amount of university funds coming from industry is significantly correlated with individual engagement. Faculty members from universities more involved with private companies are indeed more likely to engage themselves in collaboration activities with industry: this can be an effect of both wider opportunities for collaboration and a more supportive institutional culture.

Model (2) builds on the base specification by adding the variable capturing the level of engagement of the local cohort. The explanatory power of the model increases significantly when we add the first independent variable with the R-squared going from 0.15 to 0.2. The influence of the engagement of an individual's cohort is positive and significant, suggesting that the actions of a researcher are affected by the behaviors 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 explore how the benefits from collaboration perceived by the cohort influence the individual engagement behavior. First, we notice an improvement in the explanatory power from the baseline model. Moreover, cohort's perceptions of benefits are positively and significantly correlated with individual engagement: being surrounded by people who are supportive of collaboration activities with industry increases the likelihood of the researcher engaging himself in this kind of activities, as predicted by H2c.

In model (4) we then analyze the effect of the barriers from collaboration perceived by the cohort. The introduction of the new variable does not improve the explanatory power of the regression and the cohort's perception of barriers does not have any significant effect on individual engagement. Therefore, we have no evidence to support H2d.

Model (5) includes all independent variables of interest. The coefficients remain consistent for all variables. Using this specification we can compare the relative effects of the independent variables on individual engagement. As we are employing an OLS model, the interpretation and the comparisons between coefficients are straightforward: the coefficients correspond in fact to the marginal derivatives of the main function. The coefficient for the local cohort engagement is 0.16, while the coefficient for the local cohort perceived benefits is 0.06: we can therefore affirm that peers' behaviors have a stronger influence on individuals' actions than peers' motivations, which are more difficult to observe. This result supports H3.

To check for unobserved heterogeneity which can explain commonality of behaviors without imitation (Bikhchandani 1992; Manski 1993), we introduce, along with the main independent variables, an additional variable measuring the outside cohort engagement. Following the approach adopted by Bercovitz and Feldman (2008), we investigate whether an individual's decision to engage is driven by unobservable departmental variables rather than social learning, as we postulated in our hypothesis. Under his specification, the coefficients of the three main independent variables remain unchanged, while the coefficient of the outside cohort engagement variable is not significant. We can then conclude that our results are indeed driven by social learning and not by some characteristics of the department we are not able to control for.

Finally, models (7) and (8) explore the effect of peers' on researchers' attitudes towards engagement. As we constructed the two dependent variables to be ranging from 0 to 1, we apply fractional logistic models. Model (7) analyses how individual perceptions of benefits derived from engagement are influenced by peers' perceptions of benefits. We find that local cohort perceptions of benefits have a positive and significant effect on individual perceptions of benefits, as predicted by H2a. Model (8) explains how individual perceptions of barriers derived from engagement are influenced by peers' perceptions of barriers. We find that local cohort perceptions of barriers have a positive and significant effect on individual perceptions of barriers, as predicted by H2b. It is interesting to note that in this case, previous work experience in the private sector seems to play no significant role in shaping an individual's perceptions of potential barriers derived from collaboration. The two last models highlight the importance of local environment in shaping one's beliefs about certain behavior, in this case engagement with industry.

Table 8: Regressions results

VARIABLES	(1) Industrial involvement	(2) Industrial involvement	(3) Industrial involvement	(4) Industrial involvement	(5) Industrial involvement	(6) Industrial involvement	(7) Benefits	(8) Barriers
Gender	-0.0523	-0.0585	-0.0712*	-0.0523	-0.0664*	-0.0708**	0.225***	0.170**
	(0.0378)	(0.0366)	(0.0378)	(0.0373)	(0.0365)	(0.0326)	(0.0525)	(0.0857)
Academic rank	0.150***	0.0773**	0.139***	0.145***	0.0807**	0.0672*	0.0329	0.0560
	(0.0416)	(0.0334)	(0.0408)	(0.0429)	(0.0345)	(0.0343)	(0.0501)	(0.0515)
Industry experience	0.0214***	0.0208***	0.0207***	0.0213***	0.0205***	0.0166***	0.0210***	-0.00950
	(0.00397)	(0.00406)	(0.00402)	(0.00401)	(0.00407)	(0.00289)	(0.00601)	(0.00645)
Academic age	-0.00588***	-0.00541***	-0.00593***	-0.00604***	-0.00558***	-0.00479***	-0.00656***	-0.00533***
	(0.00176)	(0.00146)	(0.00165)	(0.00175)	(0.00142)	(0.00136)	(0.00209)	(0.00204)
British PhD	0.223**	0.197**	0.209**	0.217**	0.191**	0.188**	0.156*	-0.159**
	(0.0773)	(0.0737)	(0.0751)	(0.0767)	(0.0733)	(0.0692)	(0.0914)	(0.0655)
Elite PhD	-0.0661	-0.0682*	-0.0613	-0.0653	-0.0652	-0.0551	-0.0505	-0.0112
	(0.0468)	(0.0385)	(0.0461)	(0.0466)	(0.0391)	(0.0388)	(0.0666)	(0.0260)
Individual grants	0.0132	0.0106	0.0155	0.0130	0.0120	0.00822	0.0104	-0.0125
	(0.0147)	(0.0137)	(0.0154)	(0.0146)	(0.0142)	(0.0140)	(0.0129)	(0.0137)
Star	0.201**	0.192**	0.197**	0.212**	0.196**	0.235***	0.0183	-0.105
	(0.0684)	(0.0664)	(0.0659)	(0.0709)	(0.0687)	(0.0626)	(0.0854)	(0.160)
Basic discipline	-0.276**	-0.204**	-0.210*	-0.278**	-0.184**	-0.183**	-0.224***	-0.0879
	(0.117)	(0.0877)	(0.103)	(0.116)	(0.0812)	(0.0811)	(0.0855)	(0.0716)
Department funds	6.21e-07	4.30e-07	5.36e-07	6.09e-07	4.12e-07	4.56e-07	3.14e-07	1.62e-07
	(4.30e-07)	(2.94e-07)	(3.51e-07)	(4.31e-07)	(2.79e-07)	(2.66e-07)	(3.23e-07)	(2.32e-07)
Department research quality	0.143	0.0503	0.169	0.122	0.0647	-0.0797	-0.129	-0.571**
	(0.288)	(0.191)	(0.233)	(0.286)	(0.182)	(0.188)	(0.262)	(0.235)
Department size	0.000821	0.00423	-0.000793	0.00132	0.00324	0.00191	0.00789	0.0106
	(0.0128)	(0.00956)	(0.0156)	(0.0126)	(0.0112)	(0.00927)	(0.0276)	(0.0214)
University patents	-0.0452	-0.0124	-0.0254	-0.0687	-0.0198	-0.0300	-0.0700	-0.167
	(0.120)	(0.0963)	(0.110)	(0.107)	(0.0845)	(0.0978)	(0.0942)	(0.197)
University funds	0.00382**	0.00228*	0.00388**	0.00373**	0.00248**	0.00254**	0.000669	-0.00308***
	(0.00163)	(0.00109)	(0.00150)	(0.00155)	(0.00106)	(0.000959)	(0.00120)	(0.00107)

University research quality	-0.306	-0.250	-0.257	-0.234	-0.198	-0.252	-0.302	0.899**
	(0.352)	(0.267)	(0.291)	(0.335)	(0.235)	(0.204)	(0.315)	(0.400)
University size	-0.000122	-8.25e-05	-7.20e-05	-0.000149*	-7.86e-05	-5.37e-05	-0.000142	-0.000317***
	(7.83e-05)	(6.45e-05)	(7.58e-05)	(7.29e-05)	(6.14e-05)	(5.65e-05)	(0.000107)	(0.000112)
Region GDP	2.73e-08	1.71e-07	-1.07e-07	6.96e-08	1.09e-07	-6.99e-08	2.40e-07	5.01e-07
	(5.75e-07)	(4.48e-07)	(5.23e-07)	(5.45e-07)	(4.23e-07)	(3.97e-07)	(4.95e-07)	(5.62e-07)
Region R&D	0.00808	0.0115	0.00603	0.00551	0.00874	-0.00829	-0.0279	0.0180
	(0.0473)	(0.0386)	(0.0449)	(0.0466)	(0.0385)	(0.0422)	(0.0196)	(0.0523)
Region patents	7.31e-05	-2.57e-05	5.24e-05	2.07e-05	-4.77e-05	8.41e-05	0.000164	-0.000934
	(0.00111)	(0.000757)	(0.000933)	(0.00104)	(0.000690)	(0.000761)	(0.000866)	(0.00114)
Local cohort engagement		0.185***			0.158***	0.170***		
		(0.0331)			(0.0332)	(0.0349)		
Local cohort benefits			0.122***		0.0575***	0.0628***	0.287***	
			(0.0194)		(0.0174)	(0.0223)	(0.0470)	
Local cohort barriers				-0.0429	-0.0218	-0.0239		0.174***
				(0.0332)	(0.0263)	(0.0261)		(0.0455)
Outside cohort engagement						-0.00594		
						(0.0182)		
University group	yes	yes	yes	yes	yes	yes	yes	yes
Constant	1.799	1.407	1.790	1.618	1.367	1.741*	-0.262	-3.810
	(1.333)	(1.039)	(1.416)	(1.380)	(1.102)	(0.968)	(3.018)	(2.660)
Observations	1367	1367	1367	1367	1367	1214	1367	1367
R-squared	0.150	0.198	0.171	0.152	0.203	0.201		

Notes: Models (1) to (7): Ordinary Least Squares, robust standard errors clustered by discipline. Models (8) and (9): Fractional Logit, robust standard errors clustered by discipline. Two-tailed tests for controls, one-tailed tests for hypothesized variables.

*p<0.10, **p<0.05, ***p<0.01

To ensure the robustness of the model, we performed the same set of regressions using the individual industrial involvement scale standardized by the average engagement in the scientific discipline as results remain consistent with the main specification.

Further analysis

Individual engagement with industry may indicate compliance with the universities' technology transfer efforts. However, the simple observation of the behavior does not necessarily mean that the researcher entirely subscribes to the new norms attached to engagement. Moreover, academics may be facing conflicting influences: on one side their personal beliefs and their training may orient them against engagement, while the social influences and the institutional incentives may push them towards collaborative activities with industry (or *vice versa*). At the end, what we observe (the behavior) can be misaligned with the personal belief and motivations, which are likely to remain unexpressed.

We try to overcome this problem by combining researchers' behaviors and attitudes to identify for groups of academics, classified according to the alignment between their behavior and their beliefs. First of all, following the approach adopted by Bercovitz and Feldman (2008), we separate two groups of researchers: the ones who engage (defined as the individuals whose industrial involvement scale score is greater than the median score in their discipline) and the ones who do not engage. Then we extend Bercovitz and Feldman's approach by taking into account the attitudes: we classify researchers according to their perceptions of potential benefits from engagement. We get two groups: the individuals who have a perception of high benefits (defined as the individuals whose *benefits* score is greater than the median score in their discipline) and the ones who have a perception of low possible benefits. If we combine these information into a matrix, we can obtain four typologies of researchers: *substantive*, *symbolic*, *skeptic* and *snubbed* (figure 2). The distribution of the four categories across disciplines is quite even.

Figure 2: typology of academics

	Positive about engagement	Negative about engagement
High collaborators	*Substantive* (N=519)	*Skeptic* (N=187)
Low collaborators	*Symbolic* (N=257)	*Snubbed* (N=404)

Substantive academics are strong collaborators who believe engagement with industry can yield high benefits. Skeptic researchers are also strong collaborators; however, their motivations are misaligned with their behavior, as they perceive low benefits from collaboration. Symbolic academics also face a dissonance between attitudes and behavior: indeed they are positive about collaboration but they engage with industry at a low level. Finally, the group of snubbed presents low level of engagement coupled with a negative attitude towards collaboration with industry.

To investigate which is the impact of peer pressure on the likelihood of an individual to fall into a specific category, we run a multinomial logistic model with the typology of academics as the dependent variable. Snubbed is used as a reference group. We observe that for the group of substantive both peers' engagement and the perception of benefits play a significant and positive role. For the group of symbolic, only peers' perception of benefits is relevant: it is in fact likely that they have formed their positive perception of engagement from the positive attitude towards collaboration of their colleagues rather than from their own experience (which is limited as they are low collaborators). Finally, for the group of skeptic, only peers' engagement is significant: it is in fact possible that they are pushed to collaborate against their own beliefs by the fact that their colleagues are also collaborating.

References

Acs, Z. J. (1992). "Real effects of academic research: comment." The American Economic Review **82**(1): 363.

Acs, Z. J. (1994). "R & D spillovers and recipient firm size." The Review of Economics and Statistics **76**(2): 336.

Agrawal, A. and R. Henderson (2002). "Putting Patent in Context: Exploring Knowledge Transfer at MIT." Management Science **48**(1): 44-60.

Agrawal, A. and R. Henderson (2002). "Putting Patents in Context: Exploring Knowledge Transfer from MIT." Management Science **48**(1): 44-60.

Ambos, T. C. (2008). "When does university research get commercialized? Creating ambidexterity in research institutions." The Journal of management studies **45**(8): 1424.

Arvanitis, S., U. Kubli, et al. (2008). "University-industry knowledge and technology transfer in Switzerland: What university scientists think about co-operation with private enterprises." Research Policy **37**(10): 1865-1883.

Audretsch, B. (1998). "Agglomeration and the location of innovative activity." Oxf Rev Econ Policy **14**(2): 18-29.

Baldini, N. (2007). "To patent or not to patent? A survey of Italian inventors on motivations, incentives, and obstacles to university patenting." Scientometrics **70**(2): 333.

Becher, T. (1989). *Academic tribes and territories - intellectual enquiry and the cultures of disciplines*. Milton Keynes, The Society for Research into Higher Education & The Open University.

Becher, T. (1999). Professional Practices: Commitment and Capability in a Changing Environment. New Brunswick, USA, Transaction Publishers.

Bekkers, R. and I. M. Bodas Freitas (2008). "Analysing knowledge transfer channels between universities and industry: To what degree do sectors also matter?" Research Policy **37**(10): 1837-1853.

Bikhchandani, S. (1992). "A theory of fads, fashion, custom, and cultural change as informational cascades." The journal of political economy **100**(5): 992.

Blumenthal, D., E. G. Campbell, et al. (1996). "Participation of life-science faculty in research relationships with industry." N Engl J Med **335**(23): 1734-9.

Bozeman, B. and M. Gaughan (2007). "Impacts of grants and contracts on academic researchers' interactions with industry." Research Policy **36**(5): 694-707.

Breschi, S. and F. Lissoni (2001). "Knowledge Spillovers and Local Innovation Systems: A Critical Survey." Ind Corp Change **10**(4): 975-1005.

Chapple, W., A. Lockett, et al. (2005). "Assessing the relative performance of U.K. university technology transfer offices: parametric and non-parametric evidence." Research Policy **34**(3): 369-384.

Chrisman, J. J., T. Hynes, et al. (1995). "Faculty entrepreneurship and economic development: The case of the University of Calgary." Journal of Business Venturing **10**(4): 267-281.

Crane, D. (1969). "Social Structure in a Group of Scientists: A Test of the "Invisible College" Hypothesis." American Sociological Review **34**(3): 335-353.

D'Este, P. and P. Patel (2007). "University-industry linkages in the UK: What are the factors underlying the variety of interactions with industry?" Research Policy **36**(9): 1295-1313.

D'Este, P. and P. Patel (2007). "University–industry linkages in the UK: what are the factors underlying the variety of interactions with industry?" Research Policy **36**(9): 1295-1313.

Dasgupta, P. and P. David (1994). "Towards a New Economics of Science." Research Policy **23**(5): 487-522.

Etzkowitz, H., A. Webster, et al. (2000). "The future of the university and the university of the future: evolution of ivory tower to entrepreneurial paradigm." Research Policy **29**(2): 313-330.

Feldman, M. P. (1994). The geography of innovation.

Feldman, M. S. (2000). "Organizational routines as a source of continuous change." Organization Science **11**(6): 611-629.

Friedkin, N. E. (1978). "University Social Structure and Social Networks Among Scientists." The American Journal of Sociology **83**(6): 1444-1465.

Gulbrandsen, M. and J.-C. Smeby (2005). "Industry funding and university professors' research performance." Research Policy **34**(6): 932-950.

Jaffe, A. B. (1989). "Real effects of academic research." The American Economic Review **79**(5): 957.

Jensen, R. and M. Thursby (2001). "Proofs and prototypes for sale: The licensing of university inventions." American Economic Review(March): 240-259.

Kenney, M. and W. Richard Goe (2004). "The role of social embeddedness in professorial entrepreneurship: a comparison of electrical engineering and computer science at UC Berkeley and Stanford." Research Policy **33**(5): 691-707.

Knorr Certina, K. (1999). Epistemic Cultures: How the Sciencies Make Knowledge. Cambridge, MA., Harvard University Press.

Krabel, S. and P. Mueller (2009). "What drives scientists to start their own company?: An empirical investigation of Max Planck Society scientists." Research Policy **38**(6): 947-956.

Landry, R., N. Amara, et al. (2006). "Why are some university researchers more likely to create spin-offs than others? Evidence from Canadian universities." Research Policy **35**(10): 1599-1615.

Lazega, E. (2001). The Collegial Phenomenon. Oxford, Oxford University Press.

Lee, S. and B. Bozeman (2005). "The Impact of Research Collaboration on Scientific Productivity." Social Studies of Science **35**(5): 673-702.

Lee, Y. S. (1996). "`Technology transfer' and the research university: a search for the boundaries of university-industry collaboration." Research Policy **25**(6): 843-863.

Lin, M.-W. and B. Bozeman (2006). "Researchers' Industry Experience and Productivity in University–Industry Research Centers: A "Scientific and Technical Human Capital" Explanation." The Journal of Technology Transfer **31**(2): 269-290.

Link, A. N., D. S. Siegel, et al. (2007). "An empirical analysis of the propensity of academics to engage in informal university technology transfer." Ind Corp Change: dtm020.

Louis, K. S., D. Blumenthal, et al. (1989). "Entrepreneurs in Academe: An Exploration of Behaviors among Life Scientists." Administrative Science Quarterly **34**(1): 110-131.

Manski, C. F. (1993). "Identification of endogenous social effects: The reflection problem." The Review of Economic Studies **60**(3): 531.

Martinelli, A., M. Meyer, et al. (2008). "Becoming an entrepreneurial university? A case study of knowledge exchange relationships and faculty attitudes in a medium-sized, research-oriented university." The Journal of Technology Transfer **33**(3): 259-283.

Merton, R. (1973). The Sociology of Science: Theoretical and Empirical Investigations. Chicago

London, University of Chicago Press.

Nelson, R. R. (2004). "The market economy, and the scientific commons." Research Policy **33**(3): 455-471.

Nelson, R. R. and N. Rosenberg (1994). "American universities and technical advance." Research Policy **23**(3): 323-348.

Nicolaou, N. and S. Birley (2003). "Social Networks in Organizational Emergence: The University Spinout Phenomenon." Management Science **49**(12): 1702-1725.

Owen-Smith, J. (2001). "To Patent or Not: Faculty Decisions and Institutional Success at Technology Transfer." Journal of Technology Transfer **26**(1): 99-114.

Ponomariov, B. (2008). "Effects of university characteristics on scientists' interactions with the private sector: an exploratory assessment." The Journal of Technology Transfer **33**(5): 485-503.

Ponomariov, B. and P. Craig Boardman (2008). "The effect of informal industry contacts on the time university scientists allocate to collaborative research with industry." The Journal of Technology Transfer **33**(3): 301-313.

Powell, W. W., K. W. Koput, et al. (1996). "Interorganizational Collaboration and the Locus of Innovation: Networks of Learning in Biotechnology." Admistrative Science Quarterly **41**(1): 116-145.

Renault, C. (2006). "Academic Capitalism and University Incentives for Faculty Entrepreneurship." The Journal of Technology Transfer **31**(2): 227-239.

Rosenberg, N. (1982). How exogenous is science? Inside the black box: Technology and Economics. N. Rosenberg. Cambridge, Cambridge University Press: 141-159.

Rosenberg, N. and R. R. Nelson (1994). "American universities and technical advance in industry." Research Policy **23**(3): 323-348.

Rothaermel, F. T., S. H. Agung, et al. (2007). "University entrepreneurship: a taxonomy of the literature." Industrial and Corporate Change **16**: 691-791.

Sellenthin, M. (2009). "Technology transfer offices and university patenting in Sweden and Germany." The Journal of Technology Transfer.

Shane, S. (2004). Academic Entrepreneurship: University Spinoffs and Wealth Creation. MA, Edward Elgar.

Shane, S. and D. Somaya (2007). "The effects of patent litigation on university licensing efforts." Journal of Economic Behavior & Organization **63**(4): 739-755.

Stokes, D. E. (1997). Pasteur's quadrant: Basic science and technological innovation.

Van Dierdonck, R., K. Debackere, et al. (1990). "University-industry relationships: How does the Belgian academic community feel about it?" Research Policy **19**(6): 551-566.

Yang, P. Y., Y.-C. Chang, et al. (2006). "FACTORS NURTURING ACADEMIC ENTREPRENEURSHIP IN TAIWAN." Journal of Enterprising Culture **14**(4): 267-290.