# Investigating the factors that diminish the barriers to university-industry collaboration

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**Abstract**
Although the literature on university-industry links has begun to uncover the reasons for, and types of, collaboration between universities and businesses, it offers little explanation of ways to reduce the barriers in these collaborations. This paper seeks to unpack the nature of the obstacles to collaborations between universities and industry, exploring influence of different mechanisms in lowering barriers related to the orientation of universities and to the transactions involved in work with university partners. Drawing on a large-scale survey and public records, this paper explores the effects of collaboration experience, breadth of interaction, and inter-organizational trust on lowering different types of barriers. The analysis shows that prior experience of collaborative research lowers orientation-related barriers and that greater levels of trust reduce both types of barriers studied. It also indicates that breadth of interaction diminishes the orientation-related, but increases transaction-related barriers. The paper explores the implications of these findings for policies aimed at facilitating university-industry collaboration.

**Keywords:** Universities, University-industry collaboration, Barriers to collaboration, Inter-organizational trust,

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## 1. Introduction

Collaboration between industry and universities faces significant challenges including the fact that these organizations are driven by different incentive systems. Universities are primarily driven to create new knowledge and to educate, whereas private firms are focused on capturing valuable knowledge that can be leveraged for competitive advantage (Dasgupta and David, 1994). In addition, universities are becoming increasingly proactive managers of their collaborations with industry, seeking to create valuable Intellectual Property (IP) for themselves. Although both these aspects have been acknowledged in the literature on university-industry (U-I) linkages, relatively few studies have investigated the nature of the barriers and the factors that might mitigate them (Hall et al., 2001). Given the central importance given by policy to building and supporting U-I, the lack of research the obstacles to it is a serious hindrance to the design of effective policy.

In order to advance knowledge in this area, this paper examines two types of barriers: i) those related to differences in the orientations of industry and universities or what we describe as 'orientation-related barriers'; and ii) barriers related to conflicts over IP, and dealing with university administration, or what we describe as 'transaction-related barriers'. This paper explores the mechanisms can lower the degree to which firms encounter these types of barriers through an examination of three important elements that influence the firm's perception of these two obstacles to collaboration: prior collaboration experience, nature of interaction, and trust.

The analysis is based on the analysis of a large survey of UK firms that have collaborated on publicly funded research projects, combined with data from records of prior involvement in research collaboration with universities. Results show that prior collaborative experience lowers orientation-related barriers and that greater levels of trust reduce both types of barriers studied. We also find that breadth of interaction diminishes the orientation-related, but increases transaction-related barriers. We explore the implications of these findings for research and policy.

## 2. Barriers to U-I collaboration

### 2.1. Incentives and conflicts between public and private knowledge

At the core of the obstacles to U-I collaborations are the different institutional norms governing public and private knowledge (Dasgupta and David, 1994). The creation of reliable and public knowledge has been central to the growth of universities, leading to support from government for research to expand the pool of economically useful knowledge. The institutions of science include strong competitive mechanisms and powerful incentive regimes. The priority of establishing reputation through publication is critical to academic success and career sustainability. Peer esteem cannot be bought and must be created by winning reputation among colleagues.

In contrast to the relatively open nature of the science system, the process of knowledge creation in the private sector is dominated by attempts to appropriate the economic value knowledge in order to gain competitive advantage (Teece, 1986). This 'private' knowledge is largely closed, remaining hidden within the firm or disclosed in a limited way through patents filed primarily for the purposes of obtaining temporary monopolies (Dasgupta and David, 1994). Despite examples of openness (see e.g. von Hippel and von Krogh, 2003), the primary motivation of firms' knowledge creation activities is the appropriation of knowledge for private gain, and openness to external actors is used as a strategic mechanism to gain advantage over competitors (Chesbrough, 2006). Given these two different systems of knowledge production, private firms often conflict with university researchers over the topic of research and timing and form of disclosure of research results. While researchers may be keen to disclose information to gain priority, firms may wish to keep secret or appropriate the information.

### 2.2. Conflicts over IP and university administration

The growth over the past 30 years of universities as economic actors in their own right, has also been important in shaping the nature of the interaction between universities and firms. The rise of the university Technology Transfer Office (TTO) and the increasing attempts of universities to capture formal IP have had a profound impact on the nature of scientific efforts (Shane, 2004). These efforts have led to the creation of a new commercial focus on the part of the universities to create valuable IP and exploit it for financial gain (Mowery and Ziedonis, 2002).

For some, this focus on commercialization undermines the public commons of science, weakening the institutions of open science through the imposition of private norms on public activities (Nelson, 2004). For others, the rise of the university as an economic actor creates a new motor of economic development that in the past has been rarefied and separate (Etzkowitz and

Leydesdorff, 2000). It is clear that in some cases, attempts by universities to capture the commercial benefits from research have led to significant conflicts between universities and industrial partners over IP and/or disclosure of results (Shane and Somaya, 2007).

Although we know a considerable amount about the factors that lead some firms to collaborate or draw knowledge from universities (Tether, 2002), we know little about how the barriers perceived by industry to working with universities may be mitigated. Our current understanding tends to rely on information from non-collaborators, which does not provide insights into how those firms that do collaborate with universities overcome these barriers (Fontana et al., 2006). In this paper, we focus on three potential mechanisms to reduce the obstacles to U-I - collaboration experience, breadth of interaction, and inter-organizational trust.

## 3. Factors that mitigate the barriers to interaction

### 3.1. Experience of collaboration

Frequent and recurrent partners are particularly likely to capitalize on their collaboration experience by transferring the information and knowledge gained through their involvement in multiple and diverse partnerships. Recurrent collaborators are also more likely to put in place the necessary routines to reconcile conflicting views on research targets (Gomes et al., 2005), dissemination of results (Hall et al., 2003), and timing of deliverables (Van Dierdonck and Debackere, 1988), among other potential sources of conflict between university and business partners, which should lower the barriers related to research orientation. Collaboration experience should also help to lower transaction-related barriers. Research on inter-organizational alliances shows that collaboration experience is a critical determinant of the success or failure of subsequent alliances (Hagedoorn and Schakenraad, 1994). In the case of U-I links, Hertzfeld et al. (2006) find that prior collaborative experience results in standard protocols that are used as starting points for negotiations on IP ownership, facilitating the setting up of new collaborative agreements. Research collaboration experience should help to lower transaction-related barriers.

### 3.2. Breadth of interaction channels

Involvement in a variety of channels of collaboration may contribute to better equip the firm to manage conflicts over the orientation of research for at least two reasons. First, engaging in a broad range of interaction channels creates opportunities for organizational learning by exposing the firm to formalized and non-formalized interactions; face-to-face and arm's length interactions; and short/targeted and long-term/open-ended interactions. There are substantial synergies between these channels: while face-to-face and frequent interactions may not require a formalized-contractual relationship, they are crucial to improving the effectiveness of formal, long-term research agreements. Second, broad engagement also contributes to strengthening the firm's capacity to balance and align conflicting interests arising from the distinct system of incentives between academia and industry (D'Este and Patel, 2007). Therefore, it can be expected that working across different channels may raise transaction-related barriers, while at the same time the increased breadth of interaction will lower orientation-related barriers.

### 3.3. Inter-organizational trust

U-I research collaboration involves high levels of uncertainty because the research process is beset with many unknowns. Under such conditions, collaboration partners may seek to take advantage and act opportunistically to appropriate the benefits of the collaboration (Williamson, 1993). High levels of trust, on the other hand, help to reduce the fears that one of the partners will act opportunistically (Bradbach and Eccles, 1989). Trust allows the partners involved in the exchange to be confident that their collaborator will treat them fairly and in a consistent way, and will help to resolve any problems that may arise jointly. Therefore, trust may help to lower perceived barriers to collaboration. Trust expresses the capacity of firm and university to work together to resolve problems, and demonstrates a willingness to understand and adjust behaviours to align with the needs and expectations of partners (Zaheer *et al.*, 1998). For these reasons, it can be expected that high levels of trust will be associated with lower orientation-related and transaction-related barriers.

## 4. Data, method and empirical approach

To construct the sampling frame for our study, we drew on the records of research projects funded by the Engineering and Physical Sciences Research Council (ESPRC). We surveyed all the private, for-profit organizations with formal involvement in EPSRC collaborative projects between 1999-2006. resulting in a sample of 3,119 different organizations. The survey was

addressed the person responsible for the university collaboration within the organization. We decided to focus on the business unit as the unit of analysis because some of the firms in our sample are large, multi-site organizations. As U-I collaboration is often local in character, collaboration between business units and universities is likely to be decided locally rather than centrally (Criscuolo, 2005). The survey asked about the barriers to interacting with universities and the frequency of interaction by types of engagement. The response rate was just under 20 per cent. The sample covers a diverse range of firms, with representation from organizations of different sizes, across all sectors, including professional services.

### 4.1. Measures

#### 4.1.1. Dependent variable

To construct our measure of *orientation-related barriers*, we focused on the three items directly related to the orientation of university research and researchers. These are: university research is extremely orientated towards pure science; long term orientation of university research (concerns over lower sense of urgency of university researchers compared to industry researchers); and mutual lack of understanding about expectations and working practices. Each item is measured on a five point likert scale from 'strongly agree' to 'do not agree at all' and is coded 1 if respondents indicate that they 'agree' or 'strongly agree' with the statement, and 0 otherwise. To calculate the variable *orientation-related barriers*, we added these scores so that each organizations scored 0 for no barriers and a score of 3 when all orientation-related barriers are perceived as high. The measurement of transaction-related barriers includes the following four items from the question on barriers: industrial liaison offices tend to oversell research or have unrealistic expectations; potential conflicts with university regarding royalty payments from patents or other intellectual property rights and concerns about confidentiality; rules and regulations imposed by universities or government funding agencies; and absence or low profile of industrial liaison offices in the university (which was reverse coded). Our transaction-related barriers measure was created using the method described for orientation-related barriers

#### 4.1.2. Explanatory variables

We measured *collaboration experience* as the total length (in months) of research experience of working on collaborative projects with universities, funded by the EPSRC, that the organization had accumulated in the period 1991-2004. In order to capture the *breadth of interaction* between businesses and universities, we created a variable measuring the extent to which organizations use different types of interactions with universities during the period 2005–2006. We focus on joint research projects, contract research, consultancy, training of firm employees; postgraduate training in the company; recruitment of recent graduates or postgraduates; and student placements (D'Este and Patel, 2007). To construct the variable, we used a binary code for each channel of interaction, which takes the value of 1 if the firm reports having used a given interaction channel, and 0 otherwise. We then simply added up the seven interaction channels to represent the *breadth of interaction*. We also considered two other measures for breadth of interactions: a variable that captures more informal interactions related to the educational role of universities, including the items 'training of firm employees', 'postgraduate training in the company', 'recruitment of recent graduates or postgraduates' and 'student placements'. We term this variable *education-based interaction*. We created another variable to capture more formal interactions between industry and universities through contractual relationships, including the items 'joint research projects', 'contract research', and 'consultancy'. We call this variable *contract-based interaction*. Building on Zaheer et al.'s (1998) inter-organizational trust scale, we measured level of trust through four statements measured on a five-point likert scale.

#### 4.1.3. Control variables

We also included several other variables that may have an influence on the level of barriers that firms face when interacting with universities. First, we control for organization's level of absorptive capacity, measured as the percentage of staff with a higher education degree (Schmidt, 2005). The variable is categorical and ranges from 1 to 5: 1 = percentage of higher education staff equal to or less than 10%; 2 = percentage of higher education staff between 11% and 20%; 3 = percentage of higher education staff between 21% and 40%; 4 = percentage of higher education staff between 41% and 60%; and 5 = percentage of higher education staff between 61% and 100%. Second, we include a measure for firm size, i.e. number of employees, expressed in full-time equivalents, as a control variable. Third, we include a dummy variable that identifies firms

which are independent rather being part of a large group. Fourth, we include a dummy variable that equals 1 if the respondent has a doctoral degree and 0 otherwise. Finally, we also include eight dummy variables to account for inter-industry differences in patterns of U-I interaction.

## 5. Results

We use fractional logit analysis to study the relationship between the variables. In the first stage of analysis (Models 1a and 1b - Table 1), we enter only the control variables. It can be seen that absorptive capacity (percentage of higher educated staff) is negatively associated with orientation-related barriers. Further, larger firms perceive higher transaction-related barriers, and individuals with doctoral degrees are more inclined to perceive higher transaction-related barriers to interactions with universities.

**Table 1. Fractional logit regression estimates of orientation-related and transaction-related barriers to interaction**

| | Orientation-related Barriers | | Transaction-related barriers | |
|---|---|---|---|---|
| | Model 1a | Model 2a | Model 1b | Model 2b |
| *Control variables* | | | | |
| Absorptive capacity | -.08* | -.07** | .03 | .01 |
| Size | -.03 | .01 | -.02 | -.08*** |
| Independent | .02 | -.13$^{+}$ | .02 | -.00 |
| Doctoral | .08 | .13 | .42*** | .35*** |
| Industry dummies | Yes | Yes | Yes | Yes |
| *Explanatory variables* | | | | |
| Collaboration experience | | -.05** | | .00 |
| Breadth of interaction | | -.06** | | .12*** |
| Inter-organizational trust | | -.75*** | | -.37*** |
| *Statistics* | | | | |
| Log pseudolikelihood | -133.20 | -101.11 | -52.58 | -32.60 |
| df (residual) | 491 | 488 | 491 | 488 |
| No observations | 503 | 503 | 503 | 503 |

*** p ≤ .001, ** p ≤ .01, * p ≤ .05, $^{+}$ p ≤ .10; one-tailed. Standardized coefficients are reported.

In Models 2a and 2b, we introduce our key explanatory variables. The coefficient of prior collaboration experience is negatively associated with barriers related to differences in orientation (-.05; p ≤ .01), but not to barriers related to transactions-related conflicts. This suggests that routines learnt through conducting joint research with universities, lower the barriers related to the long-term nature of university research. However, experience of working with universities does not lower the perceived barriers related to university administrative procedures and conflicts over IP. Therefore, experience plays only a partial role in mitigating the barriers to U-I collaboration. Next, the results show an interesting swing in the relationship between breadth of interaction and orientation-related and transaction-related barriers, respectively: while the coefficient is significant and negative in the case of orientation-related barriers (-.06; p ≤ .01), it is significant and positive for transaction-related barriers (.12; p ≤ .001). The fact that breadth of engagement is negatively associated to orientation-related barriers suggests that collaboration involving multiple channels allows firms to cope better with the problems associated with divergent priorities and time horizons in the research. It also indicates firms' willingness to invest across many areas of engagement enables the building of routines for long-term and mutually beneficial exchanges. However, working with universities involving many different channels is also likely to involve negotiation with more university actors, including different administrative departments and possibly the TTO. As a result, broad patterns of engagement might mean involvement in numerous and lengthy interactions with university administrators, who are likely to be highly risk averse and may be responding to differing agendas and mandates. Thus, broad engagement may raise greater transaction-related barriers to collaboration. Finally, as expected, the coefficient of inter-organizational trust is negative and significant in Models 2a (-.75, p ≤ .001) and 2b (-.37, p ≤ .001), indicating that high trust in university partners is associated with lower barriers. It is interesting that trust reduces both orientation-related and transaction-related barriers. This may be because trust relies on strong bonds of mutual understanding and adjustment and, therefore, helps firms to manage their different expectations of the research and to lower the considerable transaction costs of working with universities.

**Table 2. Fractional logit regression estimates of orientation-related and transaction-related barriers to interaction involving education-based and contract-based interaction**

| | Orientation-related Barriers | | | Transaction-related barriers | | |
|---|---|---|---|---|---|---|
| | Model 3a | Model 4a | Model 5a | Model 3b | Model 4b | Model 5b |
| *Control variables* | | | | | | |
| Absorptive capacity | -.08*** | -.08** | -.07** | .02 | .02 | .01 |
| Size | -.01 | -.01 | .01 | -.06** | -.05*** | -.08*** |
| Independent | -.13$^{+}$ | -.12$^{+}$ | -.13$^{+}$ | -.01 | -.02 | -.00 |
| Doctoral | .13 | .11 | .13 | .38*** | .37*** | .35*** |
| Industry dummies | Yes | Yes | Yes | Yes | Yes | Yes |
| *Explanatory variables* | | | | | | |
| Collaboration experience | -.05** | -.05** | -.05** | .00 | .00 | .00 |
| Education-based interaction | -.09** | | -.08** | .13** | | .11* |
| Contract-based interaction | | -.05 | -.03 | | .16*** | .13*** |
| Inter-organizational trust | -.74*** | -.73*** | -.74*** | -.39*** | -.38*** | -.37*** |
| *Statistics* | | | | | | |
| Log pseudolikelihood | -101.01 | -102.27 | -100.92 | -35.20 | -35.63 | -32.58 |
| df (residual) | 488 | 488 | 487 | 488 | 488 | 487 |
| No observations | 503 | 503 | 503 | 503 | 503 | 503 |

*** $p \leq .001$, ** $p \leq .01$, * $p \leq .05$, $^{+}$ $p \leq .10$; one-tailed. Standardized coefficients are reported.

Table 2 presents the results for influence of education-based and contract-based interactions on orientation-related barriers and transaction-related barriers respectively. There is a strong negative association between education-based interactions and orientation-related barriers (-.08, $p \leq .01$), but not contract-based interactions (-.03). Also, we find that both types of interaction have a strong positive influence on the number of transaction-related barriers: .11, $p \leq .05$ for education-based interactions and .13, $p \leq .001$ for contract-based interactions. The effects of the other explanatory and control variables do not change. These results show that those interactions that involve informal and frequent face-to-face contacts contribute significantly to attenuating the orientation-related barriers, while broader interactions (both education and contract-based) increase the extent of transaction-related barriers. These findings support the above results suggesting that the differential effect of breadth of interactions on perceived barriers increases transaction-related barriers but lowers orientation-related barriers. These findings highlight the importance of education-based interactions for breaking down orientation-barriers.

## 6. Conclusions and Implications

Although it there has been recognition that there are substantial barriers to successful collaboration and knowledge exchange between universities and firms, few studies have attempted to measure and map these perceived barriers or investigate what may attenuate them. Although the 'classic' barrier to U-I collaboration – the university's long-term orientation – remains substantial, other factors are important in constraining collaboration, especially those related to IP and administrative procedures.

Some authors argue that IP-related barriers have become more prevalent in U-I interactions as a consequence of policies designed to encourage universities to increase the commercialization of research and to adopt a more aggressive strategy towards negotiations over IP (Siegel et al., 2003). While our study does not address these aspects directly, it does show that transaction-related barriers are much more difficult to mitigate than orientation-related barriers. In particular, while *collaboration experience* and *breadth of interactions* equip firms to handle (and potentially overcome) barriers related to conflicts of interest in research priorities, they do not help firms to handle IP-related barriers. In this respect, we show that transaction-related barriers are particularly sensitive to government policy and higher education governance. This trend is likely to exacerbate IP-related barriers since multiple collaborations can increase both the costs and time required to build new collaborations. At the same time, older and more informal systems of exchange and collaboration are coming under increasing scrutiny from university administrators. Such efforts to bring exchanges and interaction 'in from the cold' could have the effect of raising transaction-related barriers, especially if these efforts are organized around the requirements of central university rules and regulations. Thus, increasing attention to the management of U-I links

through government policy efforts and university administration could increase the barriers to such interactions. It would be unfortunate if the efforts to manage these interactions results in increasing the barriers. The challenge for policy is to find straightforward, simple mechanisms for management and monitoring of U-I interactions. Achieving this will require attention to the costs and benefits of management and monitoring efforts, and the weighing of the value of monitoring against negatively perceived intrusion.

An important finding from this study is that inter-organization trust is one of the strongest mechanisms for lowering the barriers to interaction between universities and industry. It suggests that the traditional system of informal reciprocity and exchange, which dominated U-I exchanges in the postwar era, should be an important part of attempts to support and build U-I collaborations.

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