

RESEARCH REPORT

1. Background

There has been an increasing focus on the role that universities can play in contributing to innovation, economic growth and wealth creation (Lambert, 2003; Sainsbury, 2007; BIS, 2009). In addition to the important core missions of research and teaching, both research and policy has focused on universities undertaking a 'third mission' (Etzkowitz et al 2000) with a focus on 'technology transfer' concentrating on the process of the commercialisation of science through such mechanisms as patents, licences and spin-outs. A range of studies have attempted to evaluate the impact of such transfers including academic spin-off activities (DiGregorio and Shane, 2003) university licensing (Shane, 2002) and science parks (Siegel et al., 2003a; 2003b) . As this research project shows, these mechanisms are important, but as it also shows, they are an incomplete representation of the wide process of knowledge exchange (D'Este and Patel, 2007) that takes place between academics from all disciplines with partners in the private, public and the so-called third sector (which includes charities, voluntary organisations and social enterprises). Furthermore, when evaluating the knowledge exchange process it is important to consider both supply push (from academia) and demand pull (from businesses and other organisation) factors.

The UK-US Innovation Benchmarking Survey (IBS) reveals the importance of investigating a broad variety of channels through which knowledge exchange activity affects business performance (Cosh et al, 2006). The IBS survey shows that that informal contacts are the most frequently cited interaction, followed by what more conventional interactions involving recruiting graduates, using publications, and attending conferences. Licensing and patenting are among the least frequently cited interactions. It also emphasises the 'public space' role that universities may play in providing opportunities for a variety of interpersonal and organisational exchanges that can inform and feed back into teaching, research and problem solving interactions. A number of studies have shown that the patterns of interactions, and their importance, vary by sector, the size and life cycle of the business, and its form of production process. Moreover their impact on businesses depends on where they impact on the value chain and the location of business activities (Gambardello and Malerba 1999; Adams and Smith 2004; Mowery and Sampat 2005; Asheim and Gertler; 2005; Brown and Ternouth 2006).

In addition to the variety of knowledge-transfer channels across sectors and types of firm, it is important to recognise the different roles that individual universities may play in their local and regional economies (for evidence on the heterogeneity of HEI contributions and involvement in the UK regions see (de la Mothe and Paquet 1998; Cooke and Morgan 1998; Rutten Boekema and Kuijpers 2003; Shane 2005; Kitson et al 2006; Kitson 2006). This heterogeneity will reflect a university's particular mission as well as the various local economic development pathways, and the role the university chooses to play in relation to them (Lester, 2005).

2. Objectives

In meeting its central objective the research addressed the following questions throughout all stages of the research. What are the modes of knowledge exchange? What are the processes by which opportunities for knowledge exchange are recognised by

businesses and academics? What factors affect the choice of modes of knowledge exchange? What are the key motivations and objectives of the parties to the knowledge exchange and their implications for the incidence and effectiveness of the exchange process? What are the impacts of knowledge exchange and how do the parties to knowledge exchange measure success and how do businesses assess the impact of knowledge exchange upon their innovative activity and value added? What are the constraints on knowledge exchange? What factors affect the geographical location of partners and the form of knowledge exchange and the consequent potential impact upon the regional and sub-regional economy of the exchange process? What are the implications of our findings for the future development of knowledge exchange policy in the UK at a national, regional and sub-regional level?

3. Methods

The research adopted a three stage multi-method approach using case study and large scale survey methodologies.

3.1 Scoping Case Studies

The first stage involved 33 case-study interviews interviews (19 large companies and 14 SMEs) which used a semi-structured questionnaire designed in collaboration with the Council for Industry and Higher Education (Brown and Ternouth, 2006). This collaboration also led to an enhanced case sample to be drawn and allowed the sample size to be greater than the 20 cases initially proposed. The cases were selected as examples of successful interactions and had two distinctive features. First, the methodology examined both the ‘demand pull’ (business) and the ‘supply push’ (academic) sides of knowledge exchange. Second, the use the case studies to inform the content and conduct of the subsequent national surveys.

The results of the case studies (Abreu et al, 2008) provided three direct inputs into the survey design. First, many businesses collaborated with academics from outside the disciplines of science and engineering. Second, interactions crossed many geographical boundaries and were frequently cross-regional. Third, many academics had knowledge exchange interactions not just with business but with the public and third sectors.

3.2 National Surveys

The national survey included a web-based survey of the academic community to address the supply side issues in knowledge exchange; and a postal survey of a stratified sample of businesses in Scotland, Wales, Northern Ireland and the English regions to evaluate the demand pull side of knowledge exchange.

3.2.1 Survey of Academics

It was initially planned that the academic survey would be restricted to academics in the UK in the physical sciences, social sciences, medicine and biological sciences, engineering and management disciplines. But as identified above this would have excluded data on the many interactions involving other disciplines such as arts and humanities. It was, therefore decided to survey all individuals in the UK academic community who were active in research or teaching in 2008-9. The survey was carried out between autumn 2008 and early summer 2009. The achieved sample of 22,170 (the planned response was 9000) represents a response rate of over 17% from a specially constructed sampling frame of 125,900 academics. Prior to the administration of the survey instrument, we

discussed with the appropriate bodies the Freedom of Information Act rules and web conventions relating to large-scale web based surveys (full details of the procedures can be found in Abreu et al, 2009)

The survey instrument was designed in the light of the case studies discussed earlier and in parallel with a survey conducted as part of an evaluation commissioned by the Higher Education Funding Council of England (HEFCE) on the impact of third stream funding on university, culture and practice (HEFCE, 2009). The sample is representative of the UK academic population in terms of age, discipline, seniority and gender and an analysis of the data suggests little response bias (see Abreu et al., 2009).

3.2.2 The Business Survey

The business survey was designed to produce a sample of businesses covering the whole of the private sector and employing 5 people or more. The sample was designed to enable analysis by size, sector and regions and all sectors of the UK economy were covered. Because of the extreme skewness of in the size distribution of businesses in the UK, a stratified random sampling approach was used which oversampled in the larger size classes in order to produce usable sample sizes in all size ranges. A pilot study resulted in a number of changes to the layout of the questionnaire. The sampling frame was from Dun & Bradstreet and the main survey was carried out from July-September 2008 with a further mailing in early 2009 and the total number of responses was 2,551 (11% response rate). A response bias analysis was carried out comparing respondents with the underlying sampling frame and analysis by response wave and is discussed in Hughes and Kitson (2010).

3.3 Follow-on Case Studies

In order to understand the process that influenced the nature and scale of benefits from knowledge exchange, the study carried out 24 case studies of ranging impacts. Each consisted of a triangulated set of interviews, including senior business management, the academic and, where appropriate, an intermediary organisation involved in the interaction. The cases confirmed the importance of informal initiation processes and their role in recognising and exploiting opportunities for further interaction, in particular in relation to human capital and training programmes.

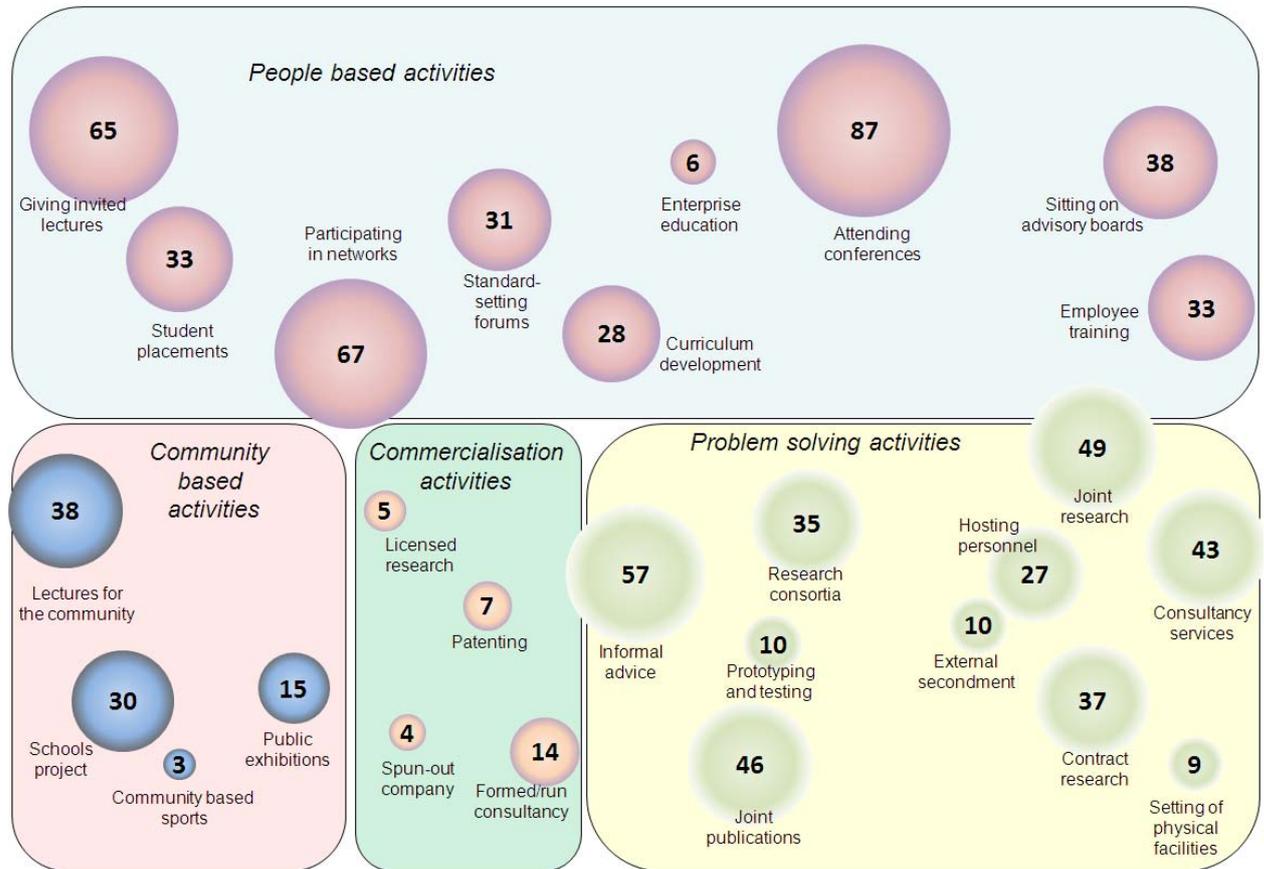
4. Results

4.1 What are the modes of knowledge exchange?

The research indicated the modes of interaction between the university sector and external organisations are multi-faceted. In identifying the patterns of interaction exhibited we grouped modes of interaction into four broad categories: technology transfer, people based, problem solving and community based. Figure 1 shows the percentage of respondents reporting each type of interaction. It is apparent that technology transfer (licensed research, patenting, spinning out of a company and the forming or running of a consultancy) are amongst the least common forms of external knowledge exchange activity when taken alongside the much wider and more frequently reported people based, problem solving and community based interactions. Many of the latter are aspects the important, but neglected, 'public space' role of universities (Cosh et al, 2006). They represent in many cases the most common and fruitful way that universities can foster a rich set of interactions which may lead to further and deeper patterns of collaborative research and teaching based activity. This finding is supported

both in the case studies and in the parallel enterprise survey, so that there is a congruence of views on this issue.

Figure 1. The external interaction activities of academics (% of respondents)



Source: Abreu et al (2009)

4.2 What are the processes by which opportunities for knowledge exchange are recognised by businesses and academics?

The development of mutual understanding and expectations is crucial if knowledge exchange is to be effective and provide benefits to all partners. This evolves in a range of ways. Institutions are often the ‘hosts’ of individuals with whom the company wishes to work based on prior history or because they are identified as leaders in their particular field. The case study research identified the importance of intermediaries or ‘boundary spanners’ who facilitate and manage contractual and relational interactions (Abreu et al. 2008).

The survey of academics reinforced this by showing that the most frequently cited initiators were individuals associated with the external organisation (80%) and the least frequently cited initiator was the University Technology Transfer Office (TTO) (24%). Demand ‘pull’ is therefore a key initiating factor. A fact reinforced by the survey of businesses initiation phase of which showed that the actions of the firm were the most important mechanism for initiating relationships. This evidence suggests a number of

important characteristics of the knowledge exchange process. First, the boundary spanners from external organisations may be more important than those based in the university. Moreover, the business survey showed that such boundary spanners are more likely to be found in big businesses compared to smaller businesses which raises important issues about generating demand pull from them. The relative minor importance of TTOs probably reflects that many of the interactions discussed below are informal and people based and do not at first require the contractual and transactional inputs from a TTO.

4.3 What factors affect the choice of modes of knowledge exchange?

From the business perspective, the choice of mode is influenced by the nature of the project and company objectives. The case studies showed that many companies frequently made comparisons of different modes. For example, where there is a perceived research interest with the potential for leveraging public funding then the project may be steered towards collaborative research, although without public funding the research may be conducted via a consultancy arrangement. Several cases cited the active processing of potential research council funding as an influence on mode selection and in one case the mode was changed from consultancy to collaborative research when it became apparent that there was the potential to leverage public funds.

4.4 What are the key motivations and objectives of the parties to the knowledge exchange and their implications for the incidence and effectiveness of the exchange process?

The survey of businesses shows that the motivations to interact are not restricted to technology development but also include service development, human resource management, training and marketing. This is important as much of the analysis and policy has focussed on the role that universities and academics play in the technological science and engineering aspects of the innovation system. But many of the motivations of business to interact with academics are not primarily concerned with innovation that aspect but with other aspects of management and business performance more generally.

As far as academics are concerned, the survey shows that they engage with businesses to support their research and teaching activities. The main motivations to engage with external organisations were concerned with developing the research activities of academics such as: gaining insights in the area of the academic's research; keeping up to date with research in external organisations; and testing the practical application of research. Conversely, the motivations that had the lowest rank were concerned with financial or commercial gain such as: personal income and business opportunities. There are some variations by discipline: in general, engineers rank all motivations higher than academics from other disciplines – from helping their research to pecuniary benefits.

4.5 What are the impacts of knowledge exchange and how do the parties to knowledge exchange measure success and how do businesses assess the impact of knowledge exchange upon their innovative activity and value added?

When assessing impacts and measures of success it is important to recognise the range of factors that drive collaboration. As noted above, businesses are not simply motivated by the factors related to technology but a wider set of business factors with innovation as one means to an overall set of performance objectives. The scoping case studies showed

that there are several methods by which companies evaluate the success of their interactions with academia, ranging from informal or subjective measures, to formal metrics-based approaches. The result from the business survey reinforced this and show that the most widely form of metric is 'qualitative information' which can take into account the skewness and unpredictability of innovation related outcomes. Other metrics used, in descending order of importance, are measures related to wider business objectives, technical objectives and investment objectives. In terms of impacts, the business survey showed that a third of collaborating firms believed that interactions with universities has a significant impact on the firms' activities with slightly more than a quarter (26%) believing that the interactions had little or no impact. The most frequently cited impacts were providing the business with new insights and strengthening the firm's reputation.

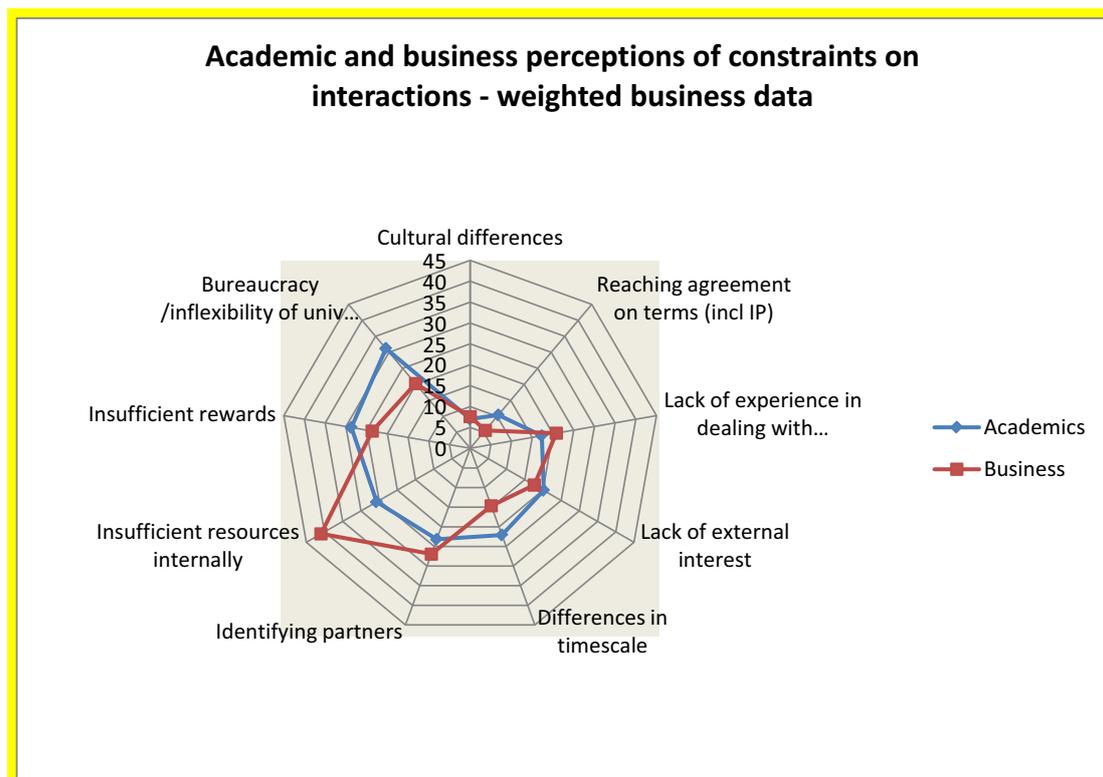
As discussed above, academics collaborate with businesses (and other organisations) to improve their core activities - research and teaching. The survey of academics shows that 73% of academics who engage with external organisation believe that it has given them new insights into their research work; 70% believe it led to new contacts in the field; 62% believe it led to new research projects; and only 11% consider that it had very little or no impact. External engagement also provided important positive impacts on teaching, although not to the same extent as the positive impacts on research: 50% of academics that are engaged with external organisations state that it has led to changes in the way they present teaching material and it has led 45% to make changes to their course programmes. There are also notable differences across discipline, the strongest impact on teaching are most apparent for academics in the arts and humanities and in the social sciences.

4.6 What are the constraints on knowledge exchange?

In addition to motivations and impacts it is also important to consider the constraints that prevent or deter interactions.

It is commonly argued that there are cultural barriers that limit interactions because universities are different to business. For instance the Lambert Report stated that: 'companies and universities are not natural partners: their cultures and their missions are different' (Lambert, 2003, p.15). It is also argued that disputes over intellectual property (IP) are an important barrier that has been becoming increasingly problematic (Bruneel et al. 2009). Figure 2 below shows, strikingly, that these constraints are not frequently cited by either firms or academics.

Figure 2. Constraints on interactions (% of respondents – comparable questions)



The evidence shows similar patterns except that businesses are more likely to identify insufficient internal resources as a constraint – reflecting the problem of making ‘demand pull’ effective, whereas academics consider bureaucracy and inflexibility of university administration as a more important constraint. It should also be noted that a lack of time is the most important constraints identified by academics (this is not shown in Figure 2 as there is not a strictly comparable constraint for businesses).

This evidence, particularly regarding IP should, however, be treated with caution. First, as identified above, many of the interactions do not involve issues regarding IP. Second, although IP has not been identified as a major constraint by businesses, the survey of businesses shows that it is the constraint that has deteriorated the most in the past three years (consistent with Bruneel et al. 2009): followed by bureaucracy and inflexibility of HEI administration; and the lack of appropriate public programmes.

It should also be noted that a majority of business do not engage with academia – and approximately 75% of those who do not engage do not consider that such interactions are relevant for the business. But it should also be noted that other frequently cited reasons for not interacting concerns informational problems – including a lack of information on the possible benefits and a lack of information on how to engage with academia.

4.7 What factors affect the geographical location of partners and the form of knowledge exchange and the consequent potential impact upon the regional and sub-regional economy of the exchange process?

The various stages of the research revealed the complex multiple geographies of interactions. Simply, there is no one dominant geographical domain that encompasses the knowledge exchange process when viewed either from a business or an academic perspective. As the case studies revealed, there is frequently a trade-off between the need for regular personal interactions which tends to generate preferences for proximity and local connections; and the need to access highly specific knowledge or expertise which may require connections with distant partners. Data from the business reveals the complex geographical patterns of interactions reported by businesses, but does show some important contrasts between different forms of knowledge exchange. First, in general, people-based interactions are more likely to be local compared to problem-based interactions (community-based interactions, not reported in the tables, are the most locally-orientated). But there are important contrasts between the specific types of interactions. The most locally orientated interactions involve training-related activities such as: enrolment on HEI courses; supervising student projects; and enterprise education. Conversely, some of the most nationally-orientated interactions include joint research with academics; involvement in research consortia involving HEIs; and using consultancy services by academics. Despite these contrasts it is important to emphasise that all interactions operate across many geographies including many - especially those involved with problem solving - that involve collaborating with international partners

The evidence from the survey of academics is consistent with the business survey results. Training based activities tend to be more locally or regionally orientated compared to problem-based activities. But what is also apparent is that academics report more international interactions indicating that UK academics tend to be more globally connected compared to the UK businesses who interact with them

The geographical distribution of interactions is also of importance in relation to debates about the role of institutions in regional development in the United Kingdom and the apparent tensions between this and the need to establish international connections and pursue the highest levels of research. As analysis of interaction by different type of institutions reveal different geographical patterns of interaction (using a simple classification of UK higher education institutions into four groups: the self-defined Russell Group; older universities (excluding Russell Group members) which were established before 1992; younger universities established post-1992; and a group of specialist institutions). The survey data reveals a clear distinction between the Russell Group and younger universities in terms of regional specialisation by academics. On all dimensions younger universities have a higher proportion of academics involved in regional people-based interactions. Conversely, academics from the Russell Group are more likely to be engaged in internationally orientated people-based interactions. The policy implication of this are discussed in the next section.

4.8 What are the implications of our findings for the future development of knowledge exchange policy in the UK at a national, regional and sub-regional level?

There has been an increasing focus on the role that universities play in the economy and the impact they make in promoting innovation and raising international competitiveness and generating increased wealth and welfare. Until recently there has been a narrow view of university-business interactions with a focus on technology transfer and

commercialisation. Although technology transfer is important, it is also necessary to focus on the more diverse and varied impacts of business-university knowledge exchange relations.

A number of key issues have arisen from this research which have implications for policy. This research shows that individual universities and the academics within them, play different and varied roles in national and regional economies. It is therefore important to bear in mind in the design of policy that universities have different strengths and that they will have different impacts on local and regional development. For instance, universities with a strong regional orientation may focus on the development of regional skills and connectivity with regional businesses. Whereas universities with an international orientation, may help attract international investment in R&D and may attract other economic actors that wish to access the UK science and knowledge base. These should be seen as complementary and not conflicting impacts.

There are many barriers to collaborations, and those that are particularly important include lack of information or lack of capacity to engage (including time and people). In view of the degree of policy interest in increasing and improving the quality of interactions, it is interesting to look at the factors which have constrained interactions with external organisations across different institutional groupings. Academics from younger universities report the greatest problems arising from the bureaucracy and inflexibility of administrators; a lack of resources devoted by their institutions to support interactions; and poor marketing, technical or negotiating skills. This suggests both that constraints are perhaps more likely to be revealed the more active individual academics are in trying to promote external relationships. Furthermore it may reflect the extent to which the relatively high degree of individual involvement with external organisations is outstripping the resources available within these institutions to support such interactions. This is an important issue for consideration in discussing the future involvement of support for third stream mission activities.

Inadequate capacity to engage with academia is evident from the results of the survey of businesses - although this is apparent across all firm sizes, it is the smaller firms that are least likely to employ somebody to liaise with academia. The research shows the importance of 'boundary spanners' - people who can connect businesses (and other institutions) to academia. Individuals or groups playing this role need to fully understand and have experience of both the academic and business environments as well as the skills to overcome barriers and foster relationships. Although some boundary spanning organisations have developed (such as Knowledge Transfer Partnerships) there is still a need to develop this capacity further. This raises important issues: first, how to train and educate 'boundary spanners'; and where such individuals or organisations should be located - in the university, the business or outside of both?

In terms of the spatial dimensions, the research shows the multiple geographies of interactions. This suggests the danger of focussing on single spatial scales for the construction and implementation of policy. It is important to build 'connective capacity' and networks that promote knowledge exchange but such networks should not be constrained to a predetermined geography or administrative boundaries.

5. Activities

The project team have presented, or will present, research findings at the following workshops, conferences and seminars.

- 1) Impact of Higher Education Institutions on regional economies initiative, Launch Conference, 10th October 2007
- 2) Workshop on the Role of Universities in Regional Development and Growth, Cambridge-MIT Institute, Cambridge 12 October 2007
- 3) National Endowment for Science, Technology and the Arts (NESTA), Policy Workshop on Open Innovation 5 December 2007
- 4) Joint CIHE/CBR Workshop, Microsoft, London, 27 May 2008
- 5) European Regional Science Association (ERSA) conference, Liverpool, 27-31 August 2008
- 6) North American Regional Science Council (NARSC) conference, New York, 20-22 November 2008
- 7) Going Global 3 Conference: New frontiers of knowledge production and the changing role of universities, British Council, London, 5 December 2008
- 8) Presentation to DIUS, London, 5 December 2008
- 9) Higher Education – Making a Difference to Economies and Communities, Conference, Belfast, 28th January 2009
- 10) Higher Education, Knowledge Exchange and the Economy Seminar, Edinburgh, 10th March 2009
- 11) What Industry Wants from Universities A Kauffman Foundation Seminar, University of San Diego, 13 March 2009.
- 12) Risk and Innovation Workshop, CRASSH, 16 April 2009.
- 13) Industrial Innovation and the Role of the Modern Research University, International Alliance of Research Universities (IARU), The Pitt Building, University of Cambridge, 27 April 2009.
- 14) Director General for Innovation’s University-Business Interaction Seminar, London, 20 May 2009.
- 15) UK-Innovation Research Centre Workshop, Cambridge, 4 June 2009
- 16) Triple Helix Conference, Strathclyde, 17-19 June 2009 (two presentations)
- 17) DRUID Summer Conference, Copenhagen, 17-19 June 2009.
- 18) China Executive Leadership Programme, 10 July 2009.
- 19) Cabinet Office Seminar, 23 September 2009.
- 20) AIM Management Practices Fellows Launch Meeting, 30 September 2009.

- 21) Symposium at Noors Slott: Changes of Science and Policy, 16 October 2009.
- 22) CST Science and Research Project Workshop, 10 November 2009, London.
- 23) Presentation to Research Councils UK, Swindon, 8 September 2009
- 24) Workshop on Interim findings from the Impact of Higher Education Institutions on Regional Economies Initiative, Scottish Funding Council, Edinburgh, September 17, 2009
- 25) Presentation of the final results of the academic survey, National Endowment for Science Technology and the Arts (NESTA), London, 20 October 2009.
- 26) Presentation of the final results, Making an Impact - Universities and the Regional Economy, Impact of Higher Education Institutions on regional economies initiative Conference, London, 20 October 2009.
- 27) CST Science and Research Project Workshop, 10 November 2009, London.
- 28) DIME Workshop, Imperial College, London, 18 November 2009
- 29) Innovation Summit: The drivers of successful innovation and the appropriation of value, London, 8 December 2009.
- 30) Presentation to HEFCE, London (with teleconference to Swindon) 14 December 2009
- 31) BIS Science and Research Seminar: Science, The Economy and Society: An Overview of the Research Base and the Role of Government, London, 15th January 2010.
- 32) Presentation at Manchester Institute of Innovation Research, 8 February 2010.
- 33) Meeting with Lord Mandelson, Lord Dryson and Professor John Beddington to discuss UK science and research policy, 9 February 2010.
- 34) DIME Workshop at Graduate School of the University of Bologna, 11-12 February 2010.
- 35) BIS OECD Innovation Policy Seminar, 16 February 2010.
- 36) AHRC Workshop: Enabling innovation: creative investments in arts and humanities research policy seminar at the Work Foundation, London, 5 March 2010.
- 37) BIS Research Strategy Conference, 12 March 2010.
- 38) ESRC Policy Event on the Impact of Social Science Research, 16 March 2010.
- 39) Cross-Council Knowledge Transfer and Economic Impact Group (KTEIG), MRC, London, 31 March 20
- 40) International Max Planck Research School for Competition and Innovation Conference, 23 October 2010.
- 41) Innovation and Entrepreneurship Conference, Tsinghua, Beijing, 9-11 July 2010.

6. Outputs

- 1) Abreu, M., Hughes, A., Grinevich, V., Kitson, M. and Ternouth, P. (2008), Universities, Business and Knowledge Exchange, Centre for Business Research, Cambridge and The Council for Industry and Higher Education (CIHE) London, available at: <http://www.cbr.cam.ac.uk/pdf/University%20Business%20Knowledge%20Exchange%20v7.pdf>
- 2) Abreu, M., Hughes, A., Grinevich, V. And Kitson, M. (2009), Knowledge Exchange between Academics and the Business, Public and Third Sectors, UK Innovation Research Centre, available at: <http://www.ukirc.ac.uk/object/report/3221/doc/AcademicSurveyReport%20201009.pdf>
- 3) Hughes, A. (2010), 'Innovation Policy, University-Industry Links, Open Innovation and the New Production of Knowledge', CBR Working Paper, Centre for Business Research, March.
- 4) Dataset: Cambridge Centre for Business Research Survey of Knowledge Exchange Activity by UK Academics.
- 5) Dataset: Cambridge Centre for Business Research Survey of Knowledge Exchange Activity by UK Businesses.

7. Impacts

The research findings have been widely circulated within the policy and academic community. For instance, in addition to international conferences, the project's research reports have been presented as evidence for the new NI Higher Education Strategy Development Group and the report on the survey of academics has been circulated amongst Government departments to inform the discussion of the funding of universities and the science base in the current financial conjuncture. The project team have been approached by individual universities who wish to evaluate and benchmark their knowledge exchange activities. Such initiatives are being discussed subject to the overriding requirement that the data collected remains anonymous and confidential. Members of the project team are currently in discussions with colleagues from DIME to develop a pan-European survey of academics based on the survey instrument developed for this project.

8. Future Research Priorities

There are three areas of research that could be developed in the future. First, the development of a pan-European survey (see above). Second, future repeat surveys of UK academics and businesses would allow the development of panel data to examine dynamics and changes over time. Third, the survey results could be linked to other datasets (such as on patents or firm's financial performance) to allow the evaluation of a wider set of research questions.

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