Building Universities into Strategic Innovation System Actors: Exploring Transitions and Organisation-Level Support at the University of Cambridge, 1996-2015

A paper submitted to the Workshop on University-Industry Collaborations and Academic Entrepreneurship: East meets West

June 5-6, 2017 – Bologna Business School, Italy

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Abstract

This paper seeks to examine how a globally leading research intensive university, the University of Cambridge, has transitioned from a 'knowledge factory' driven by scholarly publication to a 'strategic partner' for firms in the innovation system, systematically developing and nurturing more *relational* modes of interaction in addition to supporting the more transactional, arms-length commercialisation of research outputs. It focuses particularly on the changing nature and configuring of organisation-level support for university-industry linkages of different types. Using theories of organisational change, we track the institutionalisation of this type of activity at the University over the period 1996-2015 through a period of unfreezing into one of experimentation and subsequent consolidation, and finally institutionalisation in recent years. However, this process appears to take place at different speeds for commercialisation related activity and the more research-driven relational industrial partnering activity. The University has now developed a system of leadership, policies and incentives, and operational support that extends well beyond commercialisation. We observe important processes of organisational learning at play as it creates and adapts organisational functions and forms. We also suggest that the University is having to build ambidexterity not just to enable research and engagement activity to thrive, but also to enable different forms of engagement to succeed.

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1 Introduction

Research universities are becoming increasingly important partners in firms' innovation activities. Their contributions to innovation have long been recognised, generating and diffusing knowledge underpinning major technological innovation, developing instrumentation, and educating the labour force (Nelson, 1986; Jaffe, 1989; Mansfield, 1991; Cohen et al., 2002). More recently, evidence points to universities – through their interactions with industry – making significant contributions across the lifecycle of the innovation process (Lee, 2000; Cohen et al., 2002; Bercovitz and Feldman, 2007; Perkmann and Walsh, 2007; Hughes and Kitson, 2014).

Engaging with industry to create and diffuse knowledge in support of innovation is nothing new. Indeed, evidence of these interactions stretch back hundreds of years, although they were largely driven and managed by individual academics (Geuna and Muscio, 2009; Martin, 2012). Despite these interactions continuing at the academic level, post-WWII universities operated largely as 'knowledge factories', focused primarily on the mass production of codified knowledge and education (Youtie and Shapira, 2008).

Today, many universities – at least in the UK and US – have evolved to prioritise, as part of their strategic missions, not just the generation of knowledge, but also its translation and exploitation in practice in the wider innovation system to deliver greater and more direct contributions to innovation (Etzkowitz et al., 2000; Gunasekara, 2006; Youtie and Shapira, 2008; Sánchez-Barrioluengo, 2014). Strengthening this 'innovation mission' – sitting alongside and increasingly integrated with, their more traditional research and education missions – has become a policy imperative in many countries (Yusuf and Nabeshima, 2007; Hughes, 2011)

The transition from knowledge factory to strategic innovation partner has co-evolved alongside the rise in open innovation approaches within industry and growing pressures for universities to develop more active and engaged roles in improving national economic and industrial competitiveness (Perkmann and Walsh, 2007; Youtie and Shapira, 2008; Deiaco et al., 2012; Martin, 2012). The rise of open innovation in particular has seen firms placing a growing emphasis on fostering productive and effective university-industry *relationships* (Jacob et al., 2000; Lambert, 2003; Perkmann and Walsh, 2007; PCAST, 2008) compared with the more traditional transactional and arms-length technology transfer mechanisms for commercialising university-generated intellectual property (IP) (Perkmann and Walsh, 2007).

Understanding how universities transition from 'knowledge factories' driven by scientific publication and education to become strategic partners for firms in the innovation system, able to nurture productive and effective university-industry *relationships* in addition to the more traditional technology transfer mechanisms, is critical for ensuring that industry is able to more fully realise value from their interactions with universities. Extant research has explored the issue of university adaptation. However, much of it is set within the entrepreneurial university framework (see e.g. O'Shea et al., 2007; Rothaermel et al., 2007; Siegel et al., 2007; Etzkowitz, 2008; Guerrero and Urbano, 2012), which focuses primarily on knowledge diffusion and exploitation through university spin-offs and technology licensing (Gulbrandsen and Slipersæter, 2007; D'Este and Perkmann, 2011; Perkmann et al., 2013) (hereafter referred to as commercialisation). Much less is known about how universities have developed to support the building and nurturing of the full spectrum of university-industry linkages (Perkmann et al., 2013; Galán-Muros et al., 2015), including the increasingly important university-industry *relationships*.

This paper begins to addresses these issues. We undertake an in-depth case study of a major, globally leading, research university, the University of Cambridge and examine how it has transitioned over the period 1996 – 2015 from a knowledge factory where industrial engagement was largely driven by individual academics to the present day where it has become a strategic partner for firms within the innovation system. We focus specifically on strategic and operational developments within the University aimed at fostering and facilitating the development of university-industry *relationships* rather than their efforts to strengthen their traditional technology transfer activities. The latter have been well studied in general (see e.g. O'Shea et al., 2007; Rothaermel et al., 2007; Etzkowitz, 2008; Guerrero and Urbano, 2012) as well as in the case of Cambridge (Breznitz, 2014).

2 Background literature

The shifts towards knowledge-driven economies and more open modes of innovation, as well as growing pressures from governments on universities taking more active roles in addressing socio-economic and techno-industrial challenges, are creating significant external pressures for universities to adapt (Youtie and Shapira, 2008; Deiaco et al., 2012; Martin, 2012). To take advantage of these emerging opportunities and shifting landscapes they have to become more flexible and responsive (Clark, 1998). This requires strengthened leadership capability to help strategically guide the university as an institution, working closely with the academic community. It also requires an academic community that embraces emergent opportunities and roles for the institution, and a working environment within which experimenting with new ways of working across disciplines and with external partners can be fostered and brought mainstream (Clark, 1998; Youtie and Shapira, 2008).

As universities develop to become more actively engaged in innovation processes, they require an effective system of organisational support that enables productive and valuable university-industry linkages to emerge and thrive (Galán-Muros et al., 2015). However, while Galán-Muros et al. (2015) demonstrate the importance of having different types of organisational support (management support, incentives, offices and promotion) for not just commercialisation activity but also research- and education-related UILs, little is known about how these different types of support manifest themselves in support of different types of UIL, and crucially, how universities build and configure this system of support.

2.1 The nature of the organisational system within universities for university-industry linkages

While there is a dearth of evidence on the nature and configuration of the organisational system of support for UILs beyond commercialisation, an extensive body of work has examined the development of the 'entrepreneurial university' focusing particularly on the entrepreneurial activities of university spin-offs and technology licensing (Siegel et al., 2003; Shane, 2004; O'Shea et al., 2007; Rothaermel et al., 2007; Etzkowitz, 2008; Nelles and Vorley, 2010; Guerrero and Urbano, 2012; Breznitz, 2014). The systematic review by Rothaermel et al. (2007) reveals a wide range of elements to this system being developed including: leadership support and university policies (e.g. covering intellectual property rights (IPR) and royalty distribution); incentives at different levels; culture, historical context and past experiences; intermediary agents (e.g. the technology transfer office (TTO) and incubators). They highlight that the organisational system is set within an academic community with a particular motivation, capability, quality and level of experience. They also emphasise the role of industry conditions and wider government policy in mediating the technology transfer process. Research has also found that the structure, capabilities and processes of the organisational structures

supporting engagement (i.e. the TTO in the case of technology transfer) are important (Siegel et al., 2003; Rothaermel et al., 2007) as is the overall mission of the university in fostering a conducive environment (O'Shea et al., 2007).

However, much of the attention of this literature has been on the organisational system built to support commercialisation. Much less well understood is the extent to which universities are developing their organisational systems to support the wider spectrum of university-industry linkages (Perkmann et al., 2013; Galán-Muros et al., 2015), including the increasingly important university-industry *relationships* identified by Perkmann and Walsh (2007). One recent development is the work by Galán-Muros et al. (2015). Taking a much broader perspective they found evidence that support infrastructure was indeed important for a wide range of university-industry linkages including research-related engagements, education-related engagements, and commercialisation. They distinguished a strategic level (top management support, and incentives) and an operational level (offices, and internal promotion of opportunities).

Youtie and Shapira (2008) also take a broad view of how universities contribute to innovation and economic development through varieties of university-industry linkages from technology commercialisation to building university-industry relationships with existing companies to taking leadership roles to address regional problems. In their analysis of the transformation of Georgia Institute of Technology to become an 'innovation hub' they argue the importance of proactive leadership in strategically guiding the transition, coupled with the creation and accumulation of boundary spanning functions and roles both within the university and with external partners, and the building of university capabilities to play more active roles in innovation and economic development. Consistent with Clark (1998) they emphasise the importance of university leadership in fostering an "experimental culture within the institution, where faculty can seek and obtain support for new ideas, usually from external sponsors, although many times with some internal seed funding" (Youtie and Shapira, 2008 p. 1195).

2.2 Exploring university transitions: towards a framework

A second important and related question for this paper is how universities transition from a knowledge factory to one that strategically embraces the diffusion and deployment of knowledge through the building and nurturing of productive university-industry linkages. As with firms making the shift from closed to open innovation (Chiaroni et al., 2010), the transition of universities from a more closed academic system to one which is more open to industrial partnering strongly integrated with their core research activity will likely require significant organisational change (Clark, 1998; Youtie and Shapira, 2008).

Understanding how universities make this transition therefore requires an examination of the organisational change process. Armenakis and Bedeian (1999) argue that many of the process theories exploring organisational change originate from the seminal work of Lewin (1947) who conceptualised the process of change in terms of a progression through three key phases: unfreezing, moving and refreezing (or institutionalising). The first phase establishes the need and urgency for change and establishes a new vision for the organisation. The second phase sees the establishment of new incentives, structures, processes and routines for realising the new vision. This phase typically involves a degree of experimentation as organisations search for approaches that are best suited to their particular circumstances and ambitions (Chiaroni et al., 2010). The third phase sees organisations consolidate the changes and improvements and make them irreversible, preventing a reversion to the prior status quo.

Changes of the type we are exploring in this paper can also be considered in terms of context, content, process, outcome and leadership (Pettigrew et al., 2001; Kuipers et al., 2014). *Context* refers to the changing environment (e.g. political, economic, etc); *content* focuses on the strategies, structures and systems; *process* is the actual intervention required to make change happen; *outcomes* are the criterion variables such as changed attitudes and behaviours; and *leadership* covers both the political and administrative aspects (Kuipers et al., 2014). These insights can help us understand the complex, multi-level interdependencies inherent in processes of organisational change.

The transformation of *universities* presents an interesting and special case in the study of organisational change. Unlike firms, the power of the university leadership to enact and implement organisational changes top-down is severely limited in comparison with their counterparts in firms (Deiaco et al., 2009a). On the contrary, successful university transformations are believed to emerge through an interactive and collective process involving both the leadership *and* the academic community (Clark, 1998; Deiaco et al., 2009b).

For the purposes of this paper, we will be considering the transformation of the University of Cambridge from 'knowledge factory' to strategic partner for innovation along two axes. For the horizontal axis, we follow Armenakis and Bedeian (1999) and Chiaroni et al. (2010) and deploy Lewin's (1947) three phases to analyse the changes over time. In order to provide additional focus on specific aspects of the change at the national and university level, we also consider the state prior to the process of change being initiated, and divide our consideration of *moving* into two phases of *experimentation* and *consolidation*.

For the vertical axis, we examine different levels of organisational development, drawing upon the literature on university organisational support for university-industry linkages (O'Shea et al., 2007; Rothaermel et al., 2007; Breznitz, 2014; Galán-Muros et al., 2015), coupled with insights on organisational change more generally provided by Kuipers et al. (2014). We consider changes at the national political and policy level; the strategic focus of the university; university policies and incentives; and university operational structures.

This gives us a framework for structuring our analysis as shown in Figure 1.

Figure 1 Framework for structuring analysis

Element of system	**Phases of organisational transformation**				
	Prior state	*Unfreezing*	*Moving*		*Institutionalising*
			Experimentation	Consolidation	
Political context					
Strategic focus					
Policies and incentives					
Operational structures					

3 Method

To explore how universities transition from a 'knowledge factory' to become a strategic partner in innovation systems, and examine the nature of the organisational system emerging in support of different types of UILs, we deploy the framework on an in-depth case study of the University of Cambridge in the United Kingdom (UK).

The United Kingdom provides a unique opportunity to study university transformation. Going back to 1999, the government has allocated institution-level funding targeted at building the capabilities and capacity within universities to develop university-industry linkages. As part of this process, universities have had to submit details to the government on how they are developing their internal organisational systems in this space. These documents provide a valuable source of evidence on the strategic focus of the institution *at that time*, and the elements and configuration of the system they believed to be important for delivering their strategic priorities. The documents also provide important context within which the strategic choices were being made.

Following Clark (1998), we argue that understanding university transformation is most appropriately carried out when firmly embedded within its own unique and peculiar context and circumstances. Given the complexities of the transition to become a strategic partner in innovation systems, we deliberately limit ourselves in this paper to the study of one institution, the University of Cambridge. In selecting this case, we are deliberately focusing on an outlier in the university system, which one would, *a priori*, expect organisational transitions to be particularly difficult.

The University of Cambridge was founded in 1209 and developed into one of the world's leading research universities, ranked in the top five academic institutions globally since at least 2003[1]. Historically power was vested strongly in the academic community with University leadership having very limited powers and resources. In addition, Cambridge had a diffuse and liberal approach to research commercialisation with significant autonomy vested in the academics (Segal Quince Wicksteed, 1985; Minshall et al., 2007; Breznitz, 2014). However, consistent with the wider entrepreneurial university literature, existing analyses of the transformation of University of Cambridge focus on their technology transfer activities and associated system (see e.g. Minshall et al., 2007; Breznitz, 2014) with the consequence that little is known about how the University has transformed to enable more valuable university-industry *relationships* to emerge thrive.

To gather insights into the nature of organisational developments at the University of Cambridge, we collected and analysed strategy, funding and other internal documents, reports and financial records covering the period of transition (1996 – 2015). In addition, we draw on authors' respective involvement in the organisational transformation process itself and in evaluations of the governments funding programmes in this area, and undertake an in-depth case analysis of the evolution of the nature and configuration of the organisation-level strategic focus, policies and incentives, and operational structures supporting UILs at the University of Cambridge.

4 The evolving UK landscape

It is important to consider the organisational development at the University of Cambridge within the broader transformation of the UK policy and industrial landscape within which the University is situated.

Evolving policy landscape

Over the past two decades universities have become increasingly important components of innovation policies in many countries (Yusuf and Nabeshima, 2007; Youtie and Shapira, 2008; Hughes, 2011). Within this context, there have been significant developments in the UK policy landscape supporting university-industry collaborations over the past 20 years that have shaped institution-level approaches

[1] Based on the Shanghai Ranking's Academic Ranking of World Universities, available at: http://www.shanghairanking.com/index.html, accessed on 26th August 2016. ARWU estimates the academic strength of an institution based on a weighted average of indicators of the quality of education, quality of faculty, research output and per capita academic performance.

and activities. The origin of many of these developments can be traced back to a 1993 government strategy entitled, "*Realising Our Potential: A Strategy for Science, Engineering and Technology*" (HMSO, 1993)[2]. The policy implementation activities resulting from that strategy can broadly be grouped into three phases: experimentation, consolidation, and institutionalisation.

Experimentation, 1999-2004

The introduction of dedicated funding for universities to strengthen their 'Knowledge Exchange' (KE)[3] linkages with industry began in 1999. This followed growing evidence of significant barriers hampering the formation of productive partnerships between universities and firms (Howells et al. 1998). In response, the UK government introduced a range of schemes available to universities – at the institutional level – to help address these challenges[4]. They covered different areas of activity including building capability to engage; entrepreneurship education; and seed funding for spinouts. The funds were allocated based on predominantly on fixed-term projects, secured through open competitions, and aimed to incentivise universities to experiment with different approaches (Lambert, 2003).

Consolidation, 2004-2008

Multiple schemes were then consolidated into a single fund: the 'Higher Education Innovation Fund' (HEIF) that was focused on building capability within universities to engage with industry. HEIF was deliberately broad in scope recognising the many ways through which universities could contribute to innovation. At this time a review of university-business collaboration in the UK brought together significant learning on how to strengthen policies (Lambert, 2003). This review called for significant increases in the scale of funding while maintaining the ability of universities to support a wide range of interaction mechanisms in different sectors. The review also called on the government to develop mechanisms to provide greater stability for funding to enable universities to develop stronger long-term capabilities. To achieve this, the government reformed HEIF switching it to a part-formula, part-competition based allocation method, with universities required to produce institutional strategies for KE.

Institutionalisation, 2008-present

HEIF then moved to a fully formula-based approach backed by institutional strategies for investing the funds, and – despite the financial crash of 2007-8 and the introduction of a programme of significant public sector budget cuts – saw HEIF increase in scale (to £150m p.a.). This period also saw the implementation of changes to the incentives facing academics and universities with considerations of 'impact' explicitly included in research grant allocations. In 2012, the government introduced a new funding scheme, the Research Partnership Investment Fund (RPIF) for large-scale,

[2] The document called for the UK to develop a much stronger and systemic partnership between the research base and industry and re-emphasise technology transfer policies to encourage the interchange of ideas, skills, know-how and knowledge between these parts of the innovation system. The strategy document set the scene for a 20-year period of transformation within UK universities resulting in a much more systematic and strategic approach emerging in support of technology diffusion and innovation within industry.

[3] Knowledge exchange is defined here as those direct interactions that form between universities and external partners to transfer and exchange knowledge that go beyond the traditional academic activities of scholarly publication and the production of an educated labour force.

[4] The main funding schemes included the Higher Education Reach Out to Business and the Community (HEROBC) to help build the capability within universities to engage with industry; the Science Enterprise Challenge (SEC) Fund supporting the creation of a network of university centres specialising in the teaching and practice of commercialisation and entrepreneurship; the University Challenge Fund (UCF) creating seed funds to support early stage technology ventures; and the Higher Education Active in the Community Fund (HEACF) to support community engagement activities.

longer-term research and innovation infrastructure placing university-industry partnering at its core[5]. The most recent review of university-business research collaborations recognised the importance of this type of funding for universities (Dowling, 2015).

Evolving industry landscape

During the same period as UK universities were going through the changes described above, firms in many industries were also undergoing substantial changes in their approaches to innovation with the diffusion of 'open innovation' activities (Chesbrough, 2003). A variety of competitive factors had pushed companies increasingly to seek external expertise to complement internal knowledge. Concurrently, the need emerged for companies to be able to exploit innovation through more 'open' business models. Chesbrough's articulation of the open innovation model showed how firms should be able to access and absorb external knowledge, combine it with internal knowledge and consider a variety of potential exploitation channels (Chesbrough, 2006). On one side, knowledge could enter the firm from a diverse range of sources such as other firms, universities, and customers. On the other side, knowledge developed internally could be exploited through out-licensing or spinning out new ventures.

5 Results

We now turn our attention to how the University of Cambridge has transitioned from a knowledge factory to become a strategic partner for innovation, exploring how the university *as an organisation* has evolved both the focus and configuration of its support for university-industry linkages. These changes are set against the changing policy and industrial landscape outlined in the previous section. To place the organisational transition in context, we first consider how the nature and scale of UIR activity has changed over the period.

5.1 Evolution of university-industry relationship activity at the University of Cambridge

The University makes available data on a range of UIR activities covering research council funding for basic research, and user-funded research undertaking more challenge driven research (Figure 2); course provision for external partners, consultancy, facilities and equipment service provision, and delivery of regeneration and local development programmes (Figure 3). In addition, Figure 3 provides information on the amount of income received through royalties on technology licenses and through the sale of equity shares from university spin-offs. Data in Figure 3 is only available from 2005 onwards for all variables, and from 2002 for selected variables.

[5] Research Partnership Investment Fund (RPIF)

Figure 2 Evolution of different types of research activity at Cambridge, 1989 - 2015

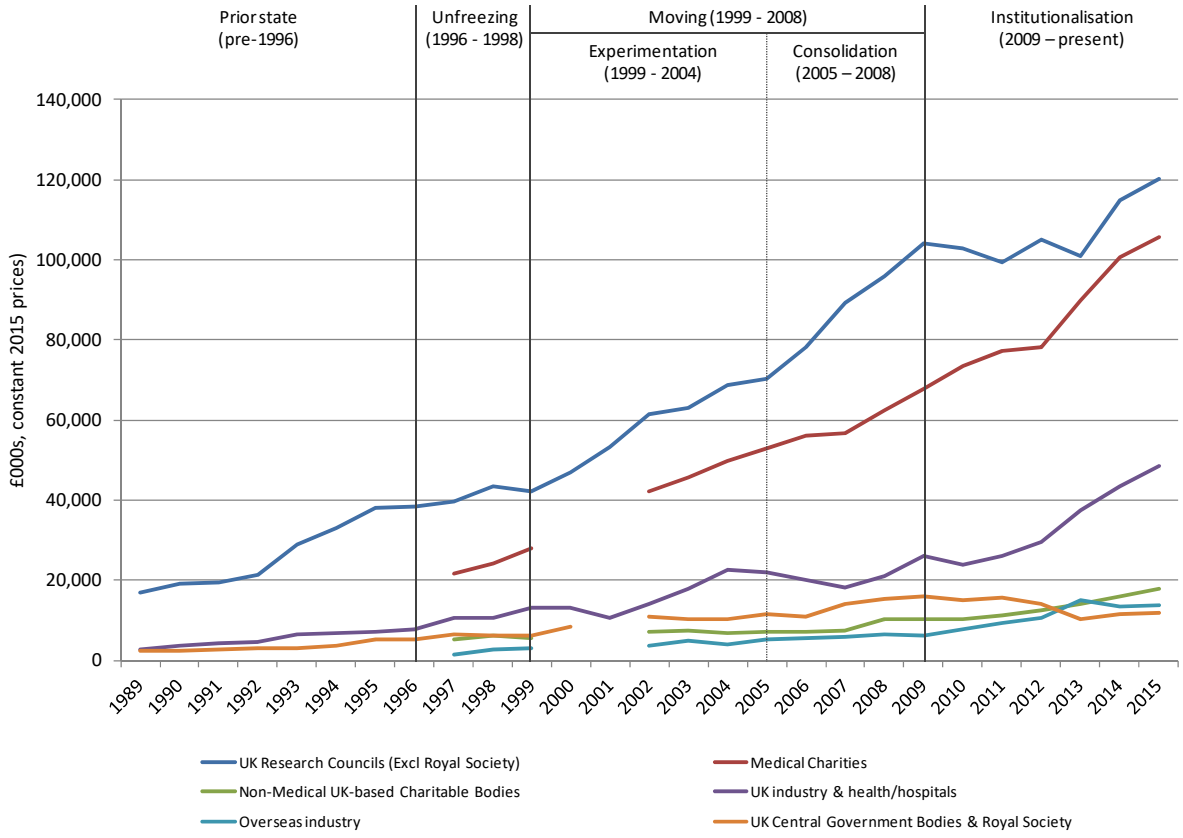

Figure 2 shows a big rise in absolute amount of research activity of different types at Cambridge between 1989 and 2015. In the prior state phase, much of the rise was dominated by increases in traditional research funding from the research councils. This strong increase continued throughout the moving phase (1999 – 2008). Coincident with this has been the significant rise in user-funded research activity, particularly for medical charities, which tend to focus on challenge-led problems in key disease and medical therapeutic areas. Research funded by UK industry and hospitals exhibited a big jump in activity in the unfreezing phase as well as from 2001-2004 during the first part of the moving phase. This type of activity fell slightly during the first half of the consolidation phase before increasing in the latter half of this phase (before and immediately post the onset of the global economic crisis). It then began to rise steeply from 2010 onwards during the institutionalisation phase.

Figure 3 Evolution of non-research related UIR activity at Cambridge, 2002 - 2015

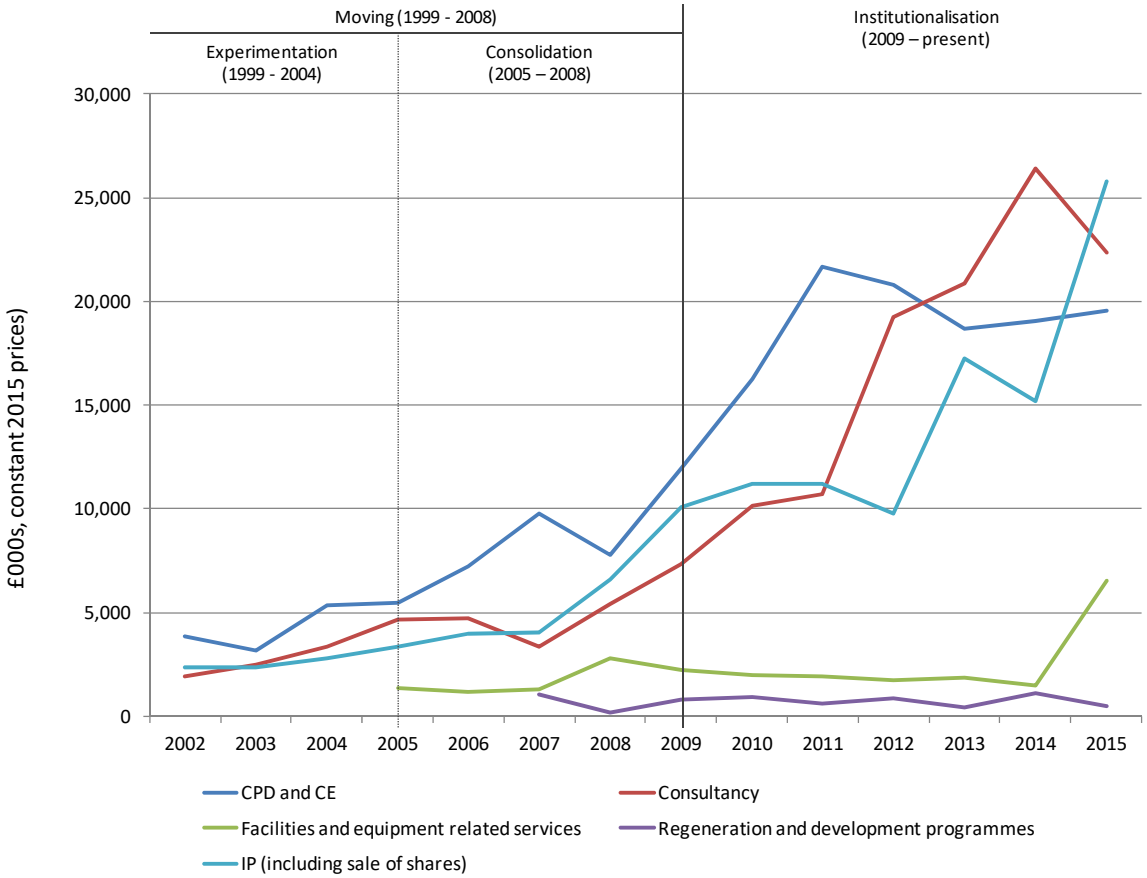

Figure 3 presents the non-research related UIR activities as well as income from commercialisation of IP. These forms of UIR have been growing significantly in scale, and while still smaller than the user-driven research activity, they are now generating significant income to the University. The non-research related UIRs are dominated by the provision of courses for external partners (e.g. large companies, SMEs, the public sector and individuals), and consultancy. Courses began to increase in scale from 2003 onwards, with big increases from 2005 – 2011. Consultancy activity began to increase significantly from 2007 onwards, with significant growth in the institutionalisation phase.

The figure also presents income generated through commercialisation of IP through both spin-outs (through the sale of equity shares) and technology licensing. While some growth in activity was exhibited between 2002 and 2007, much of the growth has come since 2007 and throughout the institutionalisation phase.

5.2 Evolution of the organisational system at the University of Cambridge

Set against this changing scale of university-industry activity has been significant effort by the University's leadership, through the allocation of institution-level resources, to develop a more supportive and conducive environment to enable both *relational* and *transactional* UILs to emerge and thrive. Our analysis of the strategic and operational developments backed at the institution-level during the different phases of transition is presented in Table 1.

Table 1 Major organisational developments during transition period at the University of Cambridge

5.2.1 Prior state (pre-1996)

For much of its history, industrial collaboration and commercialisation was a regarded by the university largely as a spillover effect of the core academic research activities with Cambridge adopting a diffuse and largely passive, liberal approach. Some initiatives were launched, but these largely emerged from the academic community, not as a result of any central policy. For example, in 1970 the Department of Engineering set up a unit that would become the Wolfson Industrial Liaison Office (WILO) tasked with facilitating, rather than controlling, research commercialisation activities. In the same year, Trinity College – one of the wealthiest Cambridge colleges – established the Cambridge Science Park that would ultimately be viewed as a key development in the emergence of the Cambridge high technology cluster. The university also had very liberal intellectual property rights (IPR) policies. IPR was not automatically assigned to the University. Individual academics had significant freedom to negotiate IPR with industrial and other research sponsors, and in how they approached research commercialisation. In 1988 the university set up the Cambridge Programme for

Industry (CPI) to provide professional development and executive education for industry. This included the Cambridge University Local Industry Links (CULIL) programme that provided a forum to help catalyse new relationships between the University and the emerging local cluster of high technology SMEs. A spillover benefit from this activity was the seeding of some deep, long-lasting relationships between the university and companies.

5.2.2 Unfreezing (1996-1998)

In 1996, the University of Cambridge appointed a new Vice Chancellor[6], Alec Broers, who had been a senior researcher at IBM, Professor of Electrical Engineering at Cambridge, the Head of the Cambridge Engineering Department and non-executive director of Lucas Industries (at the time a large UK manufacturer of components for the automotive and aerospace industries). In 1998 he commissioned a review that identified the need for a new approach that could provide a more systematic, efficient and adequately resourced framework for innovation and industrial engagement. The completion of this review coincided with the UK government's launch of a range of strategic funding programmes for universities to enable them to build the capacity and capability to engage with industry. The strategic imperative provided by the new Vice Chancellor coupled with the availability of dedicated, institution-level resources heralded a period of significant experimentation in its structures and processes to engage with industry to support innovation and the commercialisation of technologies.

5.2.3 Moving: experimentation (1999-2004)

The strategic imperative provided by the new Vice Chancellor coupled with the availability of dedicated, institution-level resources heralded a period of significant experimentation in its structures and processes to engage with industry to support innovation and the commercialisation of technologies. The new strategic focus for the university sought to enhance the responsiveness of the institution to business, and transform its complex and confusing interface with industry. Core to achieving this ambition was the establishment of a set of visible support structures providing support functions enabling and nurturing different types of industrial engagement activities within the University. These included the Corporate Liaison Office (CLO), the Cambridge Entrepreneurship Centre (CEC), and the transition of WILO to become the University's Technology Transfer Office (TTO).

The CLO's mission was to "assist external organisations and the University of Cambridge to create and strengthen mutually beneficial relationships" (HEIF 1, 2001, p. X) and act as a University-wide interface with both large companies and the local high technology cluster. It aimed to create a visible, single point of entry into the University and develop internal intelligence by mapping and understanding external opportunities in key markets with internal capabilities and resources.

The CEC, established in 1999 following the successful £3 million application to the government's Science Enterprise Challenge fund, aimed to create a culture of entrepreneurship within the University. Based within the business school, it provided entrepreneurship teaching and training, advice and mentoring for early stage entrepreneurs, and a series of events (Enterprise Tuesdays) to help familiarise students with enterprise skills and local opportunities and networks. It also developed a business incubation function to help embryonic businesses to support the very early development phase before transitioning into the more formal local innovation centres and science parks.

[6] The Vice Chancellor is the senior-most leadership position in UK universities.

In 2000, WILO transitioned to become the University's TTO and reflected a decision by the University to become much more proactive about the exploitation of IPR generated through its research. It continued its support for consultancy activity through an internal sub-unit, the Cambridge University Technical Services (CUTS) and incorporated the new University Challenge Fund (UCF) following a successful funding application from the UK government securing £3 million to invest in very early stage technologies emerging from the University's research and develop them to a point where they could attract external investors.

These units were brought together in a newly created Research Services Division (RSD) alongside the traditional research contracting office to create a single office dealing with publicly funded basic research as well as the more user driven research for industry and charities. In addition, RSD sought to take the lead in developing and managing the policy and administrative frameworks within which academics pursued their own research agendas.

In 2003, major operational changes, and new functions, were introduced. CEC was moved out of RSD and reformed as the Centre for Entrepreneurial Learning (CfEL), focusing primarily on entrepreneurship teaching and training. CEC's business incubation function was moved into a newly created office, Cambridge Enterprise (CE) within RSD that brought together the various commercialisation and consultancy support functions of the University (including UCF and the TTO).

The CLO remained within the RSD and introduced a range of new functions and initiatives including the Corporate Liaison Programme (CLP), modelled on MIT's highly successful Industrial Liaison Programme, to provide a single gateway into the university for fee-paying industrial partners, with dedicated support staff to assist the process and navigate the complex internal university systems. Another initiative, "Securing Agreements", sought to address a major obstacle often noted by companies that universities were typically poor at effectively concluding the negotiations of agreements. This brought in an individual with significant transaction and negotiation experience tasked with improving capabilities and processes in this area. The CLO also expanded its events programme aimed at catalysing new linkages with potential industrial partners and investors.

The CLO also became involved in informing the development University-wide strategic plans for key areas of research which could then be used to engage external partners as well as help build internal communities of interested academics. It had become deeply involved in the development of major interdisciplinary research initiatives alongside academics and identifying potential R&D intensive partners capable of engaging in this type of research.

During this 'experimental moving' period, the University began to revise its very liberal IPR policies vesting, for the first time, IP with the University and sharing any net benefits arising between the inventor, their department and University. In 2003, it established a working group on IPR to explore future changes. In addition, it began exploring the potential to create a nexus of entrepreneurial activity at 'West Cambridge', co-locating the University's entrepreneurial and commercially-oriented services in a relatively new part campus being development to the West of the city.

5.2.4 Moving: consolidation (2005-2008)

The initial period of experimentation by the University was followed by a period of learning and consolidation within the evolving public and industrial landscape. The switch in public funding for knowledge exchange from competitive, time-limited projects to formula-driven allocation during this period provided greater flexibility and stability for Cambridge to invest longer term in its support infrastructure. The strategic focus of the university sought to build an internal culture of collaborative

knowledge creation and entrepreneurship that, building on its research excellence, positioned the institution as a leading partner for industry and a centre for wealth creation in the economy. During this period, efforts were made to expand engagement beyond the traditional areas in medicine, science and technology.

Perhaps the biggest change during this period was the introduction of new University-wide IPR policies, bringing the University in line with much of the rest of the UK. This vested ownership of IP with the University rather than the academic and proved controversial. The changes facilitated the efforts within Cambridge Enterprise to streamline internal processes and support for commercialisation.

The infrastructure set up in the previous period was largely sustained, although experimentation continued within particular units. In 2006, Cambridge Enterprise transitioned to become a limited liability company wholly owned by the University, retaining its focus as the primary provider of commercialisation and consultancy support for academics. It was moved out of RSD, with RSD now largely consisting of research contracting and the CLO. The latter was renamed the Partnership Group in 2006. CfEL continued its operations as a separate entity.

This period of consolidation also saw an increase in events targeted at building relationships with industry, research commercialisation, entrepreneurship, and supporting the high-tech cluster. The university also began to recognise the need for support for innovation and industrial engagement to be embedded within the academic community in order to encourage these activities to be an integral part of both identifying new research challenges, but also ensuring the application of research outputs.

5.2.5 Institutionalisation (2009-present)

More recently, the University has seen a growing institutionalisation and embedding of industrial collaborations and research commercialisation as core activities alongside and reinforcing of wider research and education activity. This reflects the trends within government towards more supportive policies and funding programmes. The University continued its broad-based strategy seeking to improve technology transfer and industrial engagement through a variety of knowledge exchange mechanisms. This period also saw a growing emphasis within the university in building support for UI engagement at the department-level to more proactively encourage academics to engage, and build their required capabilities to do so. Developments included exploiting a new stream of funding from UK's Research Councils to develop more effective research translation processes and associated academic and professional support capabilities. Departments used this funding in part to introduce locally based knowledge transfer facilitators whose role was to support the building of interactions and relationships with industry to support the translation and commercial application of Research Council-funded research.

The growth of department-based support for academics was similarly bolstered with the establishment by Cambridge Enterprise of a formal network of departmentally based academic champions. These individuals were tasked with raising awareness within the academic community of the benefits of engagement, supporting them through the process, and sharing best practices across the university. This reflected an expanding role for the unit in educating, and engaging with, the academic community around commercialisation.

Many of the core structures continue to operate and develop, not least Cambridge Enterprise and CfEL, having enjoyed almost a decade of relative stability. CE was subjected to formal reviews of its performance including national and international benchmarking analyses. In addition, it developed

internal tools to support the commercialisation process and identify new opportunities. It also began to provide commercialisation services to other public and charitable research organisations, particularly in the medical space, as well as partnering with other research-intensive universities' technology transfer offices to commercialise technologies in specific markets. During this time, CE was relocated to the newly built Hauser Forum at the heart of the engineering and physical sciences research cluster on campus. This provided a co-located business incubator, networking and meeting spaces, and new physical spaces to encourage academics to come together with small and large companies to explore new ideas.

The Research Services Division was separated into: the Research Operations Office (ROO) focusing on operational issues of day-to-day research negotiations and contracting; and the Research Strategy Office (RSO) providing, for the first time, formal support to the Pro-Vice-Chancellor (PVC) for Research. Part of its remit is to facilitate the development of institution-level strategic relationships with industrial and other partners. It is also tasked with nurturing the development of collaborative, cross-disciplinary research activity, and overseeing and coordinating strategically important cross-departmental grants. The University also established a set of institution-wide strategic research initiatives that seek to tackle large, societally important research challenges. These initiatives are in addition to encouraging and nurturing individually excellent research activities within its academic community.

During this period, the Cambridge Programme for Industry – in operation since 1988 – was formalised to become a fully-fledged Institute focusing on Sustainable Leadership. In addition, a new university-wide structure was created – the Centre for Science and Policy – to help nurture relationships between academics and public policymakers, encourage a two-way exchange of knowledge, and more directly address the knowledge needs of policymakers.

Furthermore, this period saw major campus developments accelerate, emphasising the desire to build stronger synergies between research and innovation activity around co-located partnerships between the university, industry and other core stakeholders in the process (e.g. the hospital and major publicly or charitably funded research institutes). A number of these major campus investments have been facilitated through the government's RPIF funding scheme requiring significant co-investment from industry. Others represent a fundamental shift within the university to develop two major clusters of research and innovation activity with industrial partnering at its core, built around biomedical research in the south of the city and technology-based research to the west. These strategic campus developments were accompanied by increased emphasis by the University on its role in the development of the local high technology cluster and in attracting R&D investments and highly skilled labour into the local economy.

6 Discussion and Conclusions

The University of Cambridge has seen significant changes at both the strategic and operational level aimed at strengthening the internal environment and support for UILs. Historically, engagements were often driven by individual relationships rather than an overarching institutional commitment and approach. Success depended on individuals being able to navigate the internal organisational environments to secure buy-in. In the absence of visible and dedicated support, the operational environment for forming UILs was complex and hard to navigate, with confusing points of entry.

The initial attempts to create an operational environment to support UILs aimed at addressing these issues, and sought to develop a wide range of support structures targeting different forms of

commercialisation *and* UI relationships to both ease access and improve and facilitate the process of forming and nurturing interactions.

Following this unfreezing and early experimentation, the university embarked on a period of learning regarding the right strategic focus, leadership functions, policies and incentives, and types of operational support functions and structures required. It also began to learn how to configure this support *system* in the context of a large, globally leading research-intensive university.

Our analysis of the university's evolution suggests that its support for commercialisation has stabilised, with core support functions and structures now in existence in the same form for over a decade. By contrast, support at the university-level for building research and innovation-related *relationships* with firms continues to adapt and change with old structures disappearing and new ones emerging. This suggests different rates of institutionalisation for commercialisation and the more relational forms of UI linkages. It suggests that the university is still learning about how it, as an organisation, can best support the latter. It may also reflect organisational learning within their industrial partners of *how* to work effectively with leading research universities to support their innovation activities.

The growth of department-based support for both commercialisation and the building of UI relationships reflects an important tension between providing centralised support for building UI relationships and increasing support at the local level.

The need for ambidexterity within universities to enable both curiosity driven research to be undertaken alongside more industry-engaged activities is increasingly well accepted (Ambos et al., 2008; D'Este and Perkmann, 2011). Our evidence also suggests that ambidexterity is also required at the level of UILs, with different incentives, structures and capabilities required to support commercialisation and UI relationship-building. Indeed, evidence from the University of California, Berkeley suggests that universities need to be aware of how commercialisation and more research-driven UILs interact with potential conflicts of interest and motivation needing to be resolved at the organisation-level (Burnside and Witkin, 2008; Mimura, 2010).

Most recently, and perhaps the most visible manifestation of the institutionalisation of the university's UIL activity to become a strategic partner for innovation, is the coupling of the development of university-level support for both commercialisation and UI relationship-building with major investments and reorganisations of the city-based campus around clusters of research, translation and innovation activity in the physical sciences (to the West and North West of the city) and biomedical and life sciences to the South). These developments place at their heart the need for greater integration and closer relationship-based interactions between the academic research base and firms in the wider innovation system.

In conclusion, the University of Cambridge has evolved through distinct phases of the unfreezing a historical approach to UI engagement driven by individual initiative, to a period of experimentation and consolidation, and, most recently, its institutionalisation as a core activity strongly integrated with its research efforts. Processes of learning and experimentation also appear to take place at different speeds for commercialisation and the UI relationships. Lastly, we suggest that the University is having to build ambidexterity into its structures to enable not just research and UI engagement to thrive, but also to facilitate different modes of UI interaction to co-exist successfully within the organisation.

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