Sub-theme 3.3 Triple Helix ecosystems and regional development

Entrepreneurial academics and regional economic development: the case of spin-offs in the London's triple helix region

HELEN LAWTON SMITH

Department of Management, Birkbeck, University of London,
h.lawton-smith@bbk.ac.uk

Helen Lawton Smith is Professor of Entrepreneurship, Department of Management, Birkbeck, University of London. She is an economic geographer. Her research career has focused on the links between entrepreneurship, innovation and regional development in national and international contexts. She is the Founder and Research Director of the Oxfordshire Economic Observatory, School of Geography and the Environment, Oxford University (http://oeo.geog.ox.ac.uk), is Honorary Professor, School of Business, Management and Economics, University of Sussex and Visiting Professor, School of Business and Engineering, Halmstad University, Sweden. She is the author of nine books and of over eighty journal articles and book chapters.

Co-authors DAVE CHAPMAN*, PETER WOOD*, TIMOTHY BARNES* AND SAVERIO ROMEO+
* University College, London,
+ Birkbeck, University of London

Entrepreneurial academics and regional economic development: the case of spin-offs in the London's triple helix region

Abstract

In this paper we show that London's universities have produced a large number of technology-based spin-offs with distinctive patterns. In particular, we show that the majority of the university-related spin-offs are small and medium-sized (SMEs) and concentrated in biomedical sectors as elsewhere (Shane 2006, Lawton Smith and Ho 2006). A high proportion are high growth or 'gazelles' (OECD 2008, Bishop et al 2009) but more than a third have left the London region either at start-up or later. The paper explores the reasons for these patterns and policy implications.

Keywords: university spin-offs, triple helix regions, London, public policy

1. Introduction

In the fallout from the global financial crisis the UK is seeking to rebalance its economy by encouraging the creation of new jobs and economic growth. Harnessing the entrepreneurial aspirations of the UK population is central to many recent policy pronouncements. Indeed in 2010 the UK's Prime Minister, in his first major speech post-election pledged to make the next decade the "most entrepreneurial and dynamic in our history" and has subsequently declared supporting UK entrepreneurs as the 'only strategy' for growth[1].

Studies in the UK and USA have identified the importance of new firms to the creation of new employment opportunities. It has been found that young high-growth firms outpace established firms in job creation. In the USA between 1997 and 2005 start-up firms were the only net source of job creation[2] . In the UK it is estimated that there is a 'vital 6%' of dynamic high-growth companies[3] that make a disproportionate contribution to the national economy generating half of the new jobs created by existing businesses between 2002 and 2008. UK policy therefore seeks to focus resources on the identification and nurturing of companies in "those industries where Britain enjoys competitive advantage"[4] by identifying and accelerating emerging industry sectors and regions that offer the promise of new commercial opportunity. Nurturing includes supporting, 'SMEs to develop their internal capability to use knowledge and resources effectively' in order to grow (BIS 2010, 13).

University spin-offs are part of that national entrepreneurship agenda. The emphasis is on 'third stream' or third mission activities i.e. increasing the pace and impact of knowledge-based venturing activities of the 'entrepreneurial university' (Etkzowitz 1983). Indeed, commercialisation of research through spin-offs and other technology transfer activities has been backed by significant public financial resources (Sainsbury

[1]http://www.bbc.co.uk/news/uk-politics-12657524
[2]http://www.kauffman.org/newsroom/u-s-job-growth-driven-entirely-by-startups.aspx
[3]http://www.nesta.org.uk/publications/assets/features/the_vital_6_per_cent
[4]http://www.bbc.co.uk/news/business-11618436

2007, DIUS 2008). The proposition in this paper is that London is a globally-focused triple helix metropolitan region (Etkowitz 2008), not only in systems of finance and trade (Sassen 1991) (industry) but also in the concentration of research in its 42 universities and other higher education institutes (HEIs) (universities) and so will be the source of high growth firms. However, identifying these firms is harder than in some regions because of issues of relocation, hence the 'government' element of the triple helix model becomes more complex in the assessment of its application.

To examine this proposition, we report on a study of university-related companies in London. We found that, although the number of spin-offs was higher than recorded in official surveys such as the annual UK Higher Education Business Community Interaction (HEBCI) survey, the vast majority of the firms were small and medium-sized (SMEs). Also as in other locations, they are concentrated in biomedical sectors and information technology (Shane 2006, Lawton Smith and Ho 2006, PACEC 2003). A high proportion are high growth or 'gazelles' (OECD 2008, Bishop et al 2009)[5] but more than a third have left the London region either at start-up or at later stages. The context to these finding is a study in the mid-2000s by Huggins (2008) who presented a negative view of London's knowledge-based venturing activities, suggesting that its universities were underperforming in creating technology spin-off companies.

Our research question therefore is how, why and in what ways is London as a region different from other locations with similar advantages? These advantages include global focus and a high concentration of universities and highly skilled staff. Specifically we compare with city-regions such as Oxfordshire and Cambridgeshire in the UK, Sweden in Gothenburg and Guelph & Waterloo in Canada and parts of Northern Italy. We suggest possible explanations of the data and consider the policy implications. We reflect on whether the 'regional' impact of the London firms is wider than the London area. For example, applications of technological advances may take place outside London because of problems of supporting spin-off growth within the city. Thus London's 'regional triple helix' remit may actually stretch much more widely across its extended commuting hinterland.

A further angle on interpreting the findings of this study (as with much university self-reported data) is that they do not capture the full economic and non-economic impacts of university-business interactions (PACEC 2009). Other forms of commercialisation activity such as consultancy and collaboration with may be more significant than university-based entrepreneurship. For example, economic links to London's research base may be dominated by the professional training and induction of graduates, as well as forms of entrepreneurship wherein universities have little direct stake. Aggregate studies show that London's innovativeness lies less in the creation of new technological inputs to the economy than in the adaptation of established technologies to novel outputs for instance in business, professional and creative activities serving national and international markets (Wood, 2009).

[5] *All enterprises with average annualised growth greater than 20% per annum, over a three year period should be considered as high-growth enterprises. Growth can be measured by the number of employees or by turnover*. Gazelles are the subset of high-growth enterprises which are up to five years old. The definition is *All enterprises up to 5 years old with average annualised growth greater than 20% per annum, over a three year period, should be considered as gazelles.(OECD 2008).*

We review possible explanations for what makes metropolitan regions distinctive as locations for high tech firms such as university spin-offs. We then use these to examine the evidence from the London study. Finally we consider the distinctive problems facing academic entrepreneurs in London and whether in the light of new policy developments, there is evidence of the situation improving.

2. Metropolitan Regions and SMEs: it's all about resources

Two strands of literature provide possible explanations for the patterns observed in the London study. The first is what makes metropolitan regions distinctive as research and entrepreneurship environments, in other words what is known about the availability of externally available resources. The second is what is known about the performance of SMEs in metropolitan regions, and university spin-offs in particular, and how that relates to the internal resource bases of companies.

2.1 Metropolitan regions

The entrepreneurial event (Shapero 1984) relates to the ways in which the decision to form a company is influenced by the regional context – how the entrepreneurial decision is embedded socially, culturally and functionally in particular institutional contexts (Doloreux, 2002). Metropolitan regions (MRs) vary in scale from world cities such as London and Tokyo to smaller but nationally important centres of population and business such as Gothenburg in Sweden and Guelph in Canada. They are characterised by typical triple helix model (Etzkowitz and Leydesdorff 201997) attributes of economic and social resource availability in the form of finance, skills, infrastructure and services, scientific, technological and analytical capacities their science bases (universities and research institutions); and through networks and entrepreneurial cultures (see Bathelt et al 2004, Huggins 2008).

Triple helix MRs therefore in principle possess the most advantageous conditions for technological change, for incubating new firms, and for supporting the technological capability of firms related to their products, production technology and need to develop new products and markets (Frenkel 2001). The term 'production milieu' (Frenkel 2001) refers to resources in the form of physical infrastructure, business services (for example firms providing technical, commercial and marketing knowledge), government incentives, quality of life, access to a pool of skilled labour with technical knowledge and specialisations, and high quality telecommunications structures. MRs are also magnets to the highly skilled, which is of particular importance especially for the development of technical innovations (McCann and Sheppard 2001). They are also the regions where the university students have the highest propensity to stay post-graduation (Faggian and McCann 2009, Harrison and Leitch 2010).

Triple helix MRs are also likely to have the headquarters of international companies and large firms, crucial markets for 'university products' (Lendel 2010). This means that larger MRs can absorb the products of universities and their spin-off companies and hence the demand for and impact of universities are stronger than in smaller regions. Such advantages for firms, however, may change over time. Decisions on whether spin-off firms start or stay in a MR and on their growth strategies is related to the continuing relative importance of different kinds of resources. For example, the

importance of the location of firm being close to the founder's home may decrease as firms expand and have other locational considerations (Frenkel 2001, Bathelt et al 2010). Frenkel argues that young firms are more dependent on the existence of markets and labour pools, hence the likelihood that they will locate in MRs. In the case of university spin-offs not only will the regional significance change but also the nature of the link to the home university change over time also varies (Bathelt et al 2010).

While the above emphasises the positive aspects of MRs as entrepreneurial environments, they are also be characterised by weak regional knowledge networks, missing the advantages of embedded interregional networks and interdependencies. Even if resources are available may not be used. For example, Harrison and Leitch (2010) found that university spin-offs in Northern Ireland generally made little use of external provision and support networks. Moreover, Huggins' (2008) suggests that smaller regions have the advantage over MRs in that the existence of networks is more transparent.

Feldman's (2001) study of how the US Capitol region became more entrepreneurial argued that the dynamics of regional change may lead, rather than follow, the investment of venture capital and the development of social capital and entrepreneurial support services. The policy implication is that, "sustained capacity building" is needed to support entrepreneurial development through human agency, adaptation and evolution on the part of policy makers. Therefore the government dimension

2.2 Performance of SMEs in metropolitan regions

We now turn to examining what is known about how university spin-offs perform in MRs and what influences their growth potential, and to what extent they are 'regional triple helix spaces' (Etzkowitz 2008, 76). To explore what university spin-offs need from different organisations external to the firm the resource-based view (RBV) and resource dependency theory (RTD) are used together as a framework. The first relates to the need for particular forms of RBV attributes among spin-off firms to stay and succeed in a city, over time, and the second shows the distinctiveness of RDT issues within metropolitan regions.

The RBV identifies firms as bundles of unique resources (financial, physical, human capital and organisational) that lead to competitive advantage (Barney 1991, Hessels and Terjesen 2010) and to sustained superior long-term performance. They are also required to enable new businesses to form and develop (Mustar et al. 2006). A central tenet of the RDT is that firms need to acquire timely resources through personal networks. RBV is concerned with the relationship between an organisation and a set of actors in the environment. It focuses on an organisation's need to overcome a lack of resources by seeking to establish relationships with (i.e. be dependent upon) others (Ulrich and Barney 1984, Pfeffer and Salancik 1978 Hessels and Terjesen 2010).

As Harrison and Leitch (2010) point out, a dynamic approach to understanding entrepreneurial systems has to be related to the changing needs for resources and interdependencies with external organisations in specific contexts. Like other start-ups, university spin-offs face specific challenges related to their originating in a non-

commercial organisation and the conflicting objectives of stakeholder (university, academic entrepreneur, management team, suppliers of finance). These may adversely affect the transition from one growth phase to the next as firms encounter 'critical junctures' requiring new resources that must be met at each stage (Vohora et al 2004). Rather than a stage model, Druihle and Garnsey (2004) classify spin-offs according to the activity of a company, how it is resourced, the way it creates value, and how returns are realised. These are considered as: i) consulting/service companies e.g. technical consulting companies building on scientists' research activities; ii) development companies set up to commercialise an immature technology especially biotechnology; iii) product-based companies e.g. target niche markets and software companies. Their analysis differs from that of Vohora et al as they argue that the maturity of entrepreneurs' internal resources and the business model selected influence the kinds of phases of ventures experience.

Bathelt et al (2010), like Druihle and Garnsey (2004) earlier, developed different typologies of spin-offs by the character of university knowledge applied and the co-localisation or not of the founders. They compared generic broad knowledge based on capabilities and focus of local incubator university withspecific knowledge which under some conditions is localised and sometimes not. Moreover, as Bathelt et al (2010) point out, it is common for firms to undergo changes in their structure through merger and acquisition, which may change these relationships.

Generally academic entrepreneurship is related to research specialisations and the timing of scientific and technological advances (Schumpeter 1934) which translate into the preponderance of spin-offs in particular sectors at a given time. This picks up on Druilhe and Garnsey's (2004) point about the kinds of resources needed by different firms and whether their resource requirements are limited or extensive (for example biomedical firms will require more financial and physical support (e.g. wetlabs) compared to IT based firms). Moreover, there may well be an optimal size of firm for certain types of activities as in the creative industries sector (Smart 2008). Hence expectations on growth of spin-offs, at least when measured by employment, miss assessments of their value on other criteria such as technological advances.

Evidence of rates of formation of spin-offs in general and in MRs in particular shows consistent patterns. The normal UK pattern is that the number of spin-offs is increasing and that more are surviving, but remain small. The Oxford city-region appears to be a partial exception to this pattern (Lawton Smith and Ho 2006). Although most spin-offs from Oxford University are small, some have been established for many decades (1950s, 1980s) and have grown to be very large for example Oxford Instruments and Sophos.

Elsewhere, for example in Canada, Sweden and Italy, the pattern of size distribution is similar. Bathelt et al (2010) studied a sample of 18 firms, mainly IT, from University of Waterloo in the Kitchener and Guelph MR. Most remain small, some within market niches that had experienced difficulties in expanding. Others were acquired or stagnated. Lindholm Dahlstrand (1997) found in the Gothenburg region, that university spin-offs are very small firms, with low growth. When annual employment growth was compared, corporate spin-offs were found to out-perform other technology-based firms; they expanded about twice as fast as the non-spin-offs and about 10 times as fast as university spin-offs. Iacobucci (2011) found that the number

of spin-offs in Italy, most of which were concentrated in the centre and North of Italy, reached a peak in 2006-7. In that sample with160 out of a possible 382 companies still operating, most companies are still very small. However, growth capacity was in firms of most recent origin. Overall, only 7.4% had a growth path (indicated by measurement of growth over 3 and 5 years of activity).

An explanation of why UK spin-offs remain small in the chemical sector (Royal Society of Chemists, RSC, 2006) is that it is a reflection of a 'soft underbelly' of spin-outs that seemed to be vehicles on which to focus further research rather than genuine attempts to set up spin-out companies which take invention to full commercialisation. The RSC study found that too many companies were formed on the basis of a single idea or patent leaving them with a weak base on which to become a viable business. Whereas most universities had invested their University Challenge Seed Fund monies[6] they had no mechanism for seeding new companies after the proof of concept stage. Consistent with the findings by Huggins (2008) and Harrison and Leitch (2010) in the UK and Iacobucci et al (2011) in Italy, this was exacerbated by a shortage of seed investors coupled with difficulties in attracting private investment into proof-of-concept funding. Iacobucci et al (2011) also found that a general problem of Italian spin-offs was that of building new resources and opportunities. Many lacked marketing skills and others had staff retention problems.

It is also evident that there are differences in the growth potential of spin-offs. Bathelt et al (2010, 523) distinguish university start-ups which are less likely to grow, arguing that university start-ups and spin-offs from pure university research have less market legitimacy than firms produced from combined university-industry collaboration, which benefit from existing industry networks and third party referrals. Harrison and Leitch (2010) similarly find that formal spin-offs with no university stake appear to be larger than those based on university intellectual property. It is suggested that this may reflect differences in age profile (e.g. Oxfordshire) or in product/market orientation (e.g. Gothenburg).

To summarise, we argue that the discussion above has its theoretical basis in availability of resources needed by firms and that evidence on spin-off firms' growth gives priority to concepts in the RBV and RDT. The discussion also highlights the complexity of issues relating to the location, demand and supply of resources and how the matching process is facilitated. We now turn to the London study to explore these issues, beginning with the entrepreneurial context.

3. London's entrepreneurial system

As a potential source of university spin-offs, London is home to more than 42 HEIs and accounts for more than 20 percent of total UK spending on Higher Education[7] and 27 percent of UK research council grant funding. These institutions educate more than 56,000 graduates per annum on 11,000 undergraduate and nearly 4,000 postgraduate courses. They include large, multi-disciplinary institutions, such as UCL and Imperial, the other 15 colleges of the University of London, and 'modern' universities such as South Bank and London Metropolitan University. In addition there are many smaller

[7] http://www.londonhigher.ac.uk/fileadmin/documents/HESAResourcesFinances2006_07.pdf (accessed October 12 2009).

specialist institutions, particularly in medical and other scientific areas, and a dense concentration of teaching hospitals and clinical trial facilities and of major biotech firms (NESTA 2006). London also has some of the UK's leading creative art and design colleges, with many offering training in technical and creative skills in media, journalism, art and design, the performing arts and information and communication technologies (ICT). These present a huge array of overlapping and complementary spin-off opportunities, ranging from the physical sciences, engineering, to architectural, media, and industrial and product design, and particularly biological and medical sciences.

In the mid-2000s where London appeared to be weak is what Harrison and Leitch (2010) would call an 'entrepreneurial system', defined as including networks, research universities, professional services and skilled labour. Huggins (2008) suggested that many universities in London were not well connected to regional finance networks and that there were weaknesses in informal networks. This problem is argued to be related to the size and number of players in its financial community 'leading to networks that are at best disjointed and at worse disconnected' (page 199). He found that resources are skewed towards London's larger and more prestigious universities, which are the 'most active knowledge ventures' (p.202).

At that time informal investment in new companies in London had fallen (Bosma and Harding 2006). They found that gaps in the provision of early stage funding in both universities and the private sector had resulted in the public sector taking on an increasing role in supply albeit with London having double the amount of public money of any other region. The flagship public sector early stage fund in London is the Capital Fund, one of nine English Regional Venture Capital Funds established in 2002 to provide risk capital to SMEs based in Greater London. The Fund now focuses on its existing portfolio of companies, supporting them in their growth and development.

Another new development, one directly focused at university spin-offs, is Imperial College's Imperial Innovations, a £300 million venture fund, which was listed on AIM stock exchange in 2006. It raised £66m over three years and now has equity holdings in 80 companies. It is looking to invest in spin-offs from other universities, and is collaborating with the UK's three other top university technology transfer arms, Cambridge Enterprise, Oxford Spin-out Equity Management and UCL Business[8].

The size and diversity of London-based HE institutions has resulted in a piecemeal approach to the providing facilities to incubate and support new academic enterprises. Unlike the university cities of Oxford and Cambridge, London lacks significant city-wide infrastructure of dedicated property.

One sector where there has been investment in infrastructure is bio-medicine and healthcare (see London Development Agency (LDA) 2003). Prior to 2006, the London BioScience Innovation Centre (LBIC) at the Royal Veterinary College in northwest London (established in 2001) was the only incubator for life-science start-up firms in London. In 2006 the Imperial BioIncubator incubator in central London was opened increasing provision. In November 2005 the LDA made a commitment to

[8] http://www.imperialinnovations.co.uk/about (accessed May 17 2011)

improve the infrastructure to support HE enterprise in the capital. The formation of London's Science and Industry Council[9] brought together leaders from industry, academia, finance and the public sector to promote London's strengths in science, technology and design to a national and international audience and advise the LDA in its long term economic development interventions. The newly formed London Economic Partnership (LEP)[10] will focus on enterprise and innovation, skills and innovation more generally. The Regional Growth Fund (2011-2014) aimed at creating jobs and "rebalancing" the economy in the face of public sector spending cuts, is also intended to stimulate entrepreneurship[11]. Recent images of London's high tech economy include Silicon Roundabout' (a concentration of firms in North east London) and the East London 'Tech City' announced by the Prime Minister in 2010, as a world-leading technology city to challenge Silicon Valley.

Given the policy focus on creation and nurturing of high-growth companies, 'sustained capacity building', this paper seeks to 'dig deeper' into HEBCI data for a number of London-based institutions. By cataloguing and tracking the performance of some university-related companies we hope to offer better insights into factors that might constrain or accelerate growth within emerging new businesses.

3. Research approach, methodology and context

The first task was to establish a database of spin-offs. Data collection on university spin-offs in the UK has been formalised in recent years and hence basic data is available. The annual Higher HE-BCI survey for the Higher Education Funding Council for England was launched in 2001. The survey's definitions (below) were used in our study in order to ensure consistency in approach. In principle, their breadth encompasses a variety of university-related companies and different routes to the exploitation of academic expertise through research and teaching (which narrower definitions would not). Bathelt et al (2010) drawing on Pirnay et al (2003) go to some lengths to capture the different types of spin-offs. They note a distinction between spin-offs sponsored by a university and others not (equivalents to staff start-ups).

- **Spin-offs** are defined as companies set-up to exploit IP that has originated from within the HEI.
- **Formal spin-offs, not HEI-owned** are those companies set-up on IP that has originated from within the HEI but on which the HEI has released ownership (usually through sale of shares and/or IP).
- **Staff start-ups** are those companies set-up by active (or recent) HEI staff but not based on IP from the institution.
- **Graduate start-ups** include all new business started by recent graduates (within 2 years) regardless of where any IP resides.

For 2008-9 the HE-BCI survey detailed a total of 982 spin-off companies nationally still active after three years, a rise of about 300 since 2003. In the period 2003-2009 the number being formed fluctuated, ranging from 167 in 2003 to 2226 in 2006-7 to

[9] http://www.lda.gov.uk/upload/pdf/Part_2_Item_03.1_20080612.pdf (accessed August 8 2009).
[10] LEPs replace the nine English Regional Development Agencies which ceased operations in 2011
[11] http://www.bis.gov.uk/policies/economic-development/regional-growth-fund

191 in 2008-9. It should be noted that the number of graduate spin-offs from this source is likely to be an underestimate, since many UK institutions make no return in this category. However, Harrison and Leitch (2010) find that the number of student and researcher spin-offs has increased sharply since 1999. In addition, some spin-offs, many of them successful businesses, were formed before their university's technology transfer office (TTO). Moreover, reliable data on outputs such as the value of spin-out companies is underreported (PAECEC 2009).

The database of university-related companies in London (the London Universities University-related companies Database, LUCD) was designed to fill the gaps in the official data. It was established from a range of published and informal sources including: HE-BCI survey returns; institutional technology transfer managers; TTO websites; informal primary sources including: interviews with academics; London Technology Network (LTN) Business Fellows[12]; and personal contacts.

Most of the data were available through the various institutions' TTOs. In a significant number of cases local departmental sources accessed by LTN Fellows supplemented and extended official records of spin-off activity. Academic founders were identified from a variety of sources including, personal contacts, university and company press releases and the merging of academic staff directories with official records of company officers. LTN Fellows were particularly useful in contributing additional information about staff (and to a lesser extent graduate) start-up companies where the university had no formal IP position.

Secondary data sources included: an on-line survey of companies in the database; the Bureau van Dijk FAME database; Companies House; the European Patent Office and the US Patent and Trademark Office. Information gathered on academic entrepreneurs and their enterprises comprised company profiles: company name, founders' names, founders' university and department affiliation, date of incorporation, sector (SIC); location; and other information about the history of the company. Performance indicators included current status; employment; financial performance; market share; and ongoing R&D activities.

The results presented here are from a pilot study of 12 universities (Table 1). They reflect the diversity of London's universities and were initially chosen to represent potential entrepreneurial activity in science and technology and the creative industries (not discussed here).

Elite	**High research intensity**	**Medium research intensity**	**Low Research intensity**
Imperial University College, London (UCL)	Kings Queen Mary London School of Pharmacy Birkbeck (all University of	Brunel City Goldsmiths (University of London)	South Bank University London Metropolitan University University of

12 http://www.ltnetwork.org/bfora/systems/xmlviewer/default.asp?arg=DS_LTN_PARTART_24/_firsttitle.xsl/20 (accessed 9 October 2009)

	London)		Westminster

Table 1 London HEI in pilot project

Table 1 ranks the institutions according to research-type. The two elite universities, Imperial College and UCL are ranked 9th and 22nd on the THE (2010) World's Top 200 Universities. Imperial College specialises in science, engineering, management and medicine and is a self-governing institute since leaving London University in 2003. In the next box, are four other London University colleges, all ranked in the top 200. Birkbeck is 'London's evening university'. The majority of its students are in full-time employment. The London School of Pharmacy is the only free-standing specialist school in the UK dedicated entirely to teaching and research in pharmacy: as a specialist institution without undergraduates it is not included in university rankings. The remaining three are all post-1992 'modern' universities. City and Goldsmiths are over hundred years old whereas Brunel, a campus university was established in the 1960s.

In order to put the performance of the London spin-offs into context, we present in Table 1 a subset of HEBCI figures relating to company formation where we have derived a Location Quotient that normalises for the number of academic staff (FPE) in each region.

	Academic Staff	**Spin-offs with some HEI ownership**		**Formal spin-offs, not HEI owned**		**Staff start-ups**	
Area		07-08	06-07	07-08	06-07	07-08	06-07
North East	6550	1.7	0.4	0.0	0.0	0.0	0.0
North West	15790	0.8	1.6	2.7	2.4	2.0	0.7
Yorkshire and the Humber	13795	1.5	1.3	0.0	0.0	0.3	0.4
East Midlands	11375	2.2	1.7	2.3	1.1	1.2	1.7
West Midlands	11360	0.9	0.4	0.0	0.5	0.4	0.7
East of England	10540	0.4	0.3	0.0	0.0	0.4	0.8
London	36415	**1.0**	**1.1**	**1.4**	**1.2**	**0.7**	**0.8**
South East	21500	0.5	1.0	0.4	0.9	0.0	0.8
South West	9860	0.6	0.3	0.9	1.9	5.4	3.9
England	137185	1.0	1.0	1.0	1.0	1.0	1.0

Table 2 Regional Location Quotients for key HE-BCI (2007-8) indicators

In London, sales of shares in spin-offs as a percentage of the regional total are well below North West, South West and neighbouring South East (Harrison and Leitch 2010). It should also be noted that the number of patent applications generally has risen faster than the rate of spin-off formation, by over a third, although the number of patents granted has fluctuated but is around a third. Moreover, income from collaborative research and especially contract research has risen. This suggests that spin-off process is not particularly profitable as income from sales of shares accounts

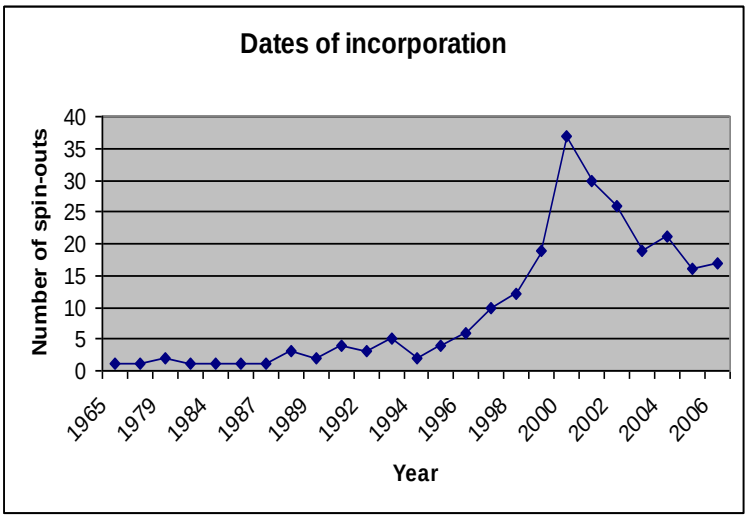
for less than one-third of all income from the exploitation of protected IP (Harrison and Leitch 2010).

4. Results

Given the uncertainties associated with the recording of start-up companies we restrict our subsequent analysis to spin-off companies including HEI owned, not owned, and staff start-ups. Graduate start-ups are only discussed where reliable data is available.

(i) date of formation of spin-offs from London and their location.

The 'entrepreneurial event' (Shapero 1984) in the form of academic spin-offs in London is relatively recent (Figure 1). The earliest identified surviving London spin-off was established in 1965. The formation rate was low until 1997, with an average number of spin-outs per year between 1965 and 1997 of around two. The great majority of London spin-outs were formed between 1998 and 2006 and almost 70% were established between 2000 and 2006. There were peaks in 2000-2001 and in 2003/4 with over 15 firms being formed per year but a fall back in numbers 2004-5 across all sectors. Hence the majority of these firms, unlike in Oxford, were formed in the 1980s around the time of the establishment of TTOs and therefore could be associated with formal measures by these universities to foster spin-offs.



The absence of many older firms may relate to the lack of a long term 'institutional memory' pre-dating the creation of TTOs. It is therefore possible but unlikely that others exist but have not been identified by the survey. However, there are implications for non-survival for the data. Unlike in Oxfordshire where there are readily identified people who have been around a long time and have memories to match, it is less easy to find such people in London. Moreover, other processes of exit such as takeovers and mergers could obscure the origins of many firms. The data, however, does show that around 8% have been acquired or have merged mainly in biotech, a pattern similar to Oxford (Lawton Smith and Ho 2006).

Assumptions about resource availability in MRs which provide locational advantages for high tech firms (Frenkel 2001) are challenged by this study. By geo-coding the companies in our database we are able to map the location of their registered offices (Figure 2). This picture clearly shows that the footprint of university-related companies spreads well outside the city's geographic and administrative boundaries.

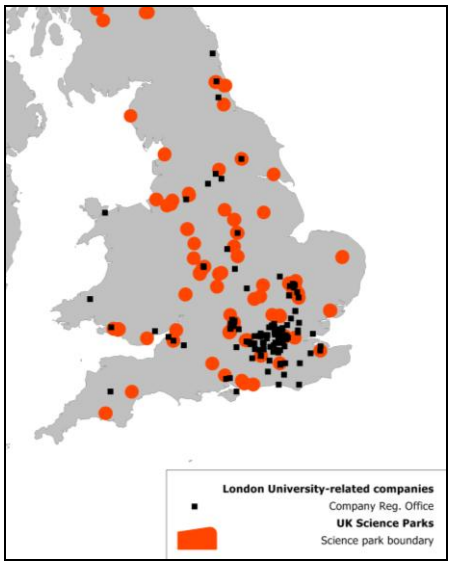
Nearly a quarter (23%) are located beyond the M25 orbital motorway, which provides a logical boundary for the capital. Given the fact that many companies are likely to operate from locations other than their registered address, this figure may underestimate this commercial diaspora. Comparing company locations on known science-park in the greater South-East it is clear that a significant number of firms are drawn to these dedicated facilities – particularly those around Oxford and Cambridge. This a very different pattern to that found in a study of university-related companies from Oxford University. There only around a sixth had moved beyond the county boundary of Oxfordshire, possibly because of the high number of incubators and science parks (Lawton Smith and Ho 2006).

It differs to other studies which suggest that university spin-offs stay close to the founders' homes (Zang 2008) but it is consistent with the argument that the importance of location of firm close to founder's home decreases as firms expand (Frenkel 2001, Bathelt et al 2010).

This migration raises questions regarding the suitability of London as a base for young university-related firms and what factors draw them away. The assumption that proximity to sources of knowledge, skills and suppliers of finance, features of metropolitan regions as suggested by Frenkel (2001) are critical location factors are not supported. By implication the RDT perspective that firms acquire timely resources through personal networks highlights a problem of scale- the sheer size of the metropolitan region possibly limits the number of established local networks that embed companies into localities (Bathelt et al 2004, Huggins 2008).

Migration might also be related to the costs of establishing or maintaining a London base. It could also be that the pattern around London reflects the extended hinterland of academic commuters therefore that firms are located nearer home than work. Hence the regional impact extends beyond the metropolitan region.

Figure 2 location of spin-offs



(ii) performance of institutions

To standardise the spin-off data for the different sizes of institutions, which Huggins (2008) does not do, Table 3 compares the spin-off totals between 1998 and 2005 with their number of Full Person Equivalent (FPE) Academic Staff in 2007-8. It does not include students/student start-ups. The results indicate a wide range of spinout 'performances', with Imperial College, South Bank University and Brunel University, (but not UCL), showing above average activity.

	Spin-offs Jan (1998-Dec 2005)	Academic Staff (FPE, 2007-8)	STEM Academic Staff (FPE 2007-8)	LQ (FPE)	Average spin-offs per 1000 Staff	Average spin-offs per 1000 FPE(STEM) Staff
Imperial College	59	3300	3158	2.6	2.2	2.3
South Bank University	8	760	310	1.5	1.3	3.2
Brunel University	10	1040	394	1.4	1.2	3.2
UCL	37	4930	3418	1.1	0.9	1.4
Queen Mary	9	1780	1104	0.7	0.6	1.0
King's College	12	3050	1995	0.6	0.5	0.8
Royal Holloway	2	1085	298	0.3	0.2	0.8
University of Westminster	1	1795	658	0.1	0.1	0.2
Goldsmiths	1	565	50	0.3	0.2	2.5
Birkbeck College	1	1715	267	0.1	0.1	0.5
Total	**140**	**20020**	**12188**	**1.0**	**0.9**	**1.4**

Table 3 University spin-offs by size of institutions (Full Person Equivalents FPE[13]) for all academic staff and for those in STEM subjects.

To allow for the varying missions of institutions we standardise for the number of academic staff. Standardising spin-off activity against the number of research staff also allows comparison with the performance of European institutes which is captured on an annual basis by the ASTP (Arundel and Bordoy 2006). This reports an average Europe wide average numbers of spin-offs per 1000 research staff of 1.48 (2004) and 1.63 (2005) based upon responses from 49 institutions. On this measure, only Imperial College outperforms the European average.

As can be seen from Table 4, university-related companies are overwhelmingly found in STEM (Science, Technology, Engineering and Medical) fields, but are dominated by the biomedical field, a pattern found in other studies (Shane 2006, Lawton Smith and Ho 2006). The combination of Pharmaceuticals & Biotechnology and Health Care equipment and services accounted for 47% of spin-offs. This dominance was expected on the basis of the London's primacy nationally and internationally in biomedical research. It is similar to patterns found in other studies (see for example PACEC 2003, Shane 2006). Software and computer services are the second largest group, followed by chemicals.

[13]source: Higher Education Database for Institutions http://www.heidi.ac.uk/

	Engineering	Humanities	Medical	Other	Science	Technical	(blank)	Total
Chemicals	5	1	4	1	11			**22**
Consultancy	3			1				**4**
Creative industry	3		1	1				**5**
Electricity	5				2			**7**
Electronic& Electrical Equipment	4		2		6			**12**
Health Care Equipment&Services	6		5		3			**14**
Industrial Engineering	6		3		3			**12**
Pharmaceuticals&Biotechnology	4		49	2	23	1	1	**80**
Software&Computer Services	8	1	4	2	4	16		**35**
Technology Hardware&Equipment	1							**1**
Telecommunications	2		1			1		**4**
#N/A	1		2		1	2		**6**
Total	**48**	**2**	**71**	**7**	**53**	**20**	**1**	**202**

Table 4 Counts of HEI spin-off companies by commercial and academic discipline[14]

[14]Using classification in PACEC (2009) Appendix F.

(iii) growth of firms

For employment by university-related companies in London, data are available for 40% (101/244) of the entire sample of university-related companies. Using the definition of SME by European Commission[15], in 2005 the entire sample group of university-related companies is composed of 63 micro enterprises, 27 small enterprises, 10 are medium enterprises and only large enterprise. Almost 90% of university-related companies are micro or small enterprises, very similar to Gothenburg (Lindholm Dahlstrand 1997), in Italy (Iacobucci 2011) and in the UK overall (Harrison and Leitch 2010).

By 2008 the 10% of companies larger than 250 employees provide more than 50% of the total employment of 3,100. London university-related technology companies (average of 12.7 persons per firm) are generally smaller than those in Oxfordshire (Lawton Smith and Ho 2006), where 114 firms generated 9000 jobs (78.94 employees per firm). Total turnover showed a similar difference in magnitude (Oxford £1bn, London £248.6 million). Several companies have gone public. In total, 13 (8%) have been floated on UK stock markets (the London Stock Exchange (LSE) and/or the Alternative Investment Market (AIM)), one more than the Oxfordshire university-related companies. This suggests and the data suggest that the London spin-offs are no worse and no better at being floated than those in other regions.

The percentage of high growth firms is small: only 31 out of entire population identified as achieving high growth (Table 4). However, more than 60% achieve this within five years of incorporation and therefore classify as Gazelles (Bishop et al 2009). This is also consistent with the pattern in Italy where growth capacity was in the firms of most recent origin (Iacobucci 2011).

Years after incorporation	Companies Achieving High Growth
3	6
4	7
5	8
6	1
7	1
8	2
11	2
12	2
14	1
15	1
Total	**31**

Table 4 high growth firms in the London sample

[15] A company is a micro enterprise if the number of employees is less than 10, small enterprise if the number of employees is between 11 and 50, medium enterprise if the number is between 51 and 250, and large enterprise if the number is more than 251 (http://ec.europa.eu/enterprise/enterprise_policy/sme_definition/index_en.htm).

The RBV provides possible explanations for the small number of large firms and the later start to firm formation in London. Both could be related to firms having inadequate financial, physical, human capital and organisational resource bases (Barney 1991, Hessels and Terjesen 2010) or business experience (Meyer 2003) at early stages. It might also be due to the absence of networks through which they can access timely resources, particularly finance, as proposed by RDT, by establishing relationships with others (Ulrich and Barney 1984, Hessels and Terjesen 2010) and/or a lack of resources in the TTO at early stages to invest in the companies and/or limited capacity to access external resources such as venture capital (c.f. Huggins 2008). It is also likely that some are primarily vehicles on which to focus research rather than genuine entrepreneurial firms, as found in the RSC (2006) study.

However, as in other sectors such as the creative industries, there is an optimal size of firm for the markets (Smart 2008). It is therefore possible that market opportunities in London are so varied that it is possible for firms to be in specialist markets and operate at a size where market position matches resource availability.

This answer to the question of whether London's University-related companies outperform general population of firms (comparison with NESTA data for 2005-8 period) is yes (Table 5). For the UK population of high growth firms the corresponding figure is 6%. However, for Greater London the NESTA survey shows a rate of about 6.8% so overall there is only a very modest difference between the sample university portfolio and general population of firms.

	2005-8 High Growth firms	Total population of surviving firms at 2005	Percentage
Pharmaceuticals&Biotechnology	9	80	11%
Software&Computer Services	2	34	6%
Electronic&Electrical Equipment	2	13	15%
Electricity	1	8	13%
Health Care Equipment&Services	1	15	7%
All sectors	15	196	8%

Table 5 high growth and surviving firms in the London sample

Although firms are generally small, consistent with HE-BCI data, these are high survival rates. Staff start-ups appear to be more robust than spin-offs with student start-ups the least likely to survive (Table 6). From RBV and RDT perspectives, academic and student entrepreneurs with limited business experience and networks are slightly less likely to start firms that survive than staff start ups (see also Harrison and Leitch 2010). Software & computer services firms are least likely to survive. This reflects rapid technological and market changes. Other sectors also seem to be vulnerable, for example electronic & electronic equipment and industrial engineering.

Category	Count	3 year survival	5 year survival
Spin-off	145	92%	82%
Staff Start-up	43	98%	91%
Student Start-up	9	89%	67%
Total	197	93%	83%

Sector	Count	3 year survival	5 year survival
Chemicals	18	94%	94%
Consultancy	1	100%	100%
Creative industry	4	100%	100%
Electricity	5	100%	100%
Electronic&Electrical Equipment	11	91%	73%
Health Care Equipment&Services	14	100%	93%
Industrial Engineering	14	79%	71%
Pharmaceuticals&Biotechnology	81	95%	84%
Software&Computer Services	34	88%	76%
Technology Hardware&Equipment	2	100%	100%
Telecommunications	4	100%	100%
Total	188	93%	84%

Table 6 survival

5. Conclusions

This paper has sought to examine the policy implications of findings from a study of university-related companies in London. The findings on the size and location of the firms show differences for London to findings in other studies, for example to university city-regions such as Oxfordshire, Cambridgeshire and Gothenburg. While we point out the specifics of the London economy and its higher education system, our methodology has more general applications, indicating where further research is needed in assessing impact and establishing causal relationships in observed formation rates, and patterns of subsequent growth and locational behaviour.

Consistent with other studies we found that the spin-offs are more likely to be established by academics in the top research institutions and in the pharmaceuticals & biotechnology sector (followed by software and computer services sector). This reflects more general trends in the number of new firms in particular sectors such as IT, trends which are geographically centred in London. There is thus a need for dedicated entrepreneurial support systems – which in London do now seem to be improving but is not yet a coherent 'regional triple helix space' (Etzkowitz 2008). . The lack of a well-developed support system (premises, networks, professional service firms) seems to more than counterbalance the advantages of remaining adjacent to the parent institution. Feldman's (2001) theory on sustained capacity building is universal (as indicated by studies from Sweden, Italy and Canada as well as Northern Ireland).

The evidence that London's university-related companies are on average considerably smaller and have not generated the same employment as in Oxfordshire might be

partially explained by data deficiencies but it is unlikely that larger firms would not have been recorded. However, the London study shows little differences to findings in numerous other studies of spin-offs in metropolitan (Lindholm Dahlstrand 1997, Bathelt et al 2010) and non-metropolitan regions (Iacobucci et al 2011, Druihle and Garnsey 2004, Harrison and Leitch 2010). It seems that there is an optimal size of firms in these sectors and that London provides niche markets in which they can operate (Smart 2008); many are research vehicles rather than genuine Schumpeterian firms, and that firms exhibit faster exit strategies (relocate, sell, cease) than in other locations. In the case of the last, it is a considerable ongoing methodological problem to capture these firms.

More interesting is that as in Italy (Iacobucci et al 2011) there is evidence of high rates of growth in the most recent firms. Further research is needed to identify whether, consistent with the RDT, London's entrepreneurial system is more supportive in that externally available resources from the public sector (finance, premises) are making a difference to the internal capacity of firms (RBV) or whether there are other explanations. While the overall contribution to employment is low, nearly a fifth of recent spin-offs meet the 2008 OECD threshold for fast-growing 'Gazelle' companies. As survival rates are relatively high, there are some grounds for believing that the future holds prospects for a greater impact of spin-offs on employment.

Moreover, consistent with other evidence (Harrison and Leitch 2010, Bathelt et al 2010), the spin-offs which are performing better are in the category 'staff spin-offs' rather than those based on university IP. Hence we concur with Harrison and Leitch (2010, 1252) that the value of university spin-offs should be 'based on a broader understanding of intellectual assets and their exploitation'. As Wood (2009) suggests London's strengths lie in the adaptation of established technologies to novel outputs, for example in business, professional and creative activities serving national and international markets. Thus the challenge for policy makers is recognise the complexity of resource needs for university spin-offs, particularly in finance, and develop ways in which sustained triple helix model 'capacity building' can be enhanced.

Acknowledgements
The authors thank London Higher and the Oxfordshire Economic Observatory for funding this study and to John Slater for his comments on this paper.

Barney, J. B. 1991 'Firm resources and sustained competitive advantage' *Journal of Management*, 17, 99-120.
Bathelt H, Malmberg A, Maskell P (2004) Clusters and knowledge: Local buzz, global pipelines and the process of knowledge creation. *Progress in Human Geography* 28, 1: 31–56
Bathelt, H, Fogler, D F and Munro, A (2010) A knowledge-based typology of university spin-offs in the context of regional economic development' *Technovation* 30 519-532
BIS 2010 A strategy for sustainable growth
http://www.bis.gov.uk/assets/biscore/corporate/docs/s/10-1058-strategy-for-sustainable-growth

Bishop K. Mason G. and Robinson C. (2009) 'Firm growth and its effects on economic and social outcomes' Interim report for NESTA March 2009 http://www.nesta.org.uk/assets/Uploads/pdf/Interim-report/firm_growth_interim_report_NESTA.pdf (downloaded August 5 2009)
Bosma, N and Harding, R (2006) Global Entrepreneurship Monitor 2006 http://www.gemconsortium.org/download/1300973129823/GEM_2006_Global_Results_Summary_V2.pdf
Doloreux, D. (2002) What We Should Know About Regional Systems of Innovation. *Technology in Society* 24, 243-263.
DIUS (2008) *Innovation Nation* London: HMSO
DTI (2005) C*omparative Statistics for the UK, European and US Biotechnology Sectors: Analysis Year 2003* Report prepared by Critical I Limited for the Department of Trade and Industry. London:DTI
Druihle C. and Garnsey E. (2004) 'Do academic spin-offs differ and does it matter?' *Journal of Technology Transfer* 29, 269–285.
Etzkowitz, H. (1983) 'Entrepreneurial scientists and entrepreneurial universities in American academic science' *Minerva* 21:198-233
Etzkowitz, H. and Leydesdorff, L.(1997) *Universities and the Global Knowledge Economy* London:Pinter
Etzkowitz, H. (2008) *The Triple Helix Model: University-Industry-Government Innovation in Action* London:Routledge
Faggian, A and McCann, P (2009) Human capital, graduate migration and innovation in British regions *Cambridge Journal of Economics* 33 2 317-333.
Feldman, M. P. 2001. The Entrepreneurial Event Revisited: Firm Formation in a Regional Context *Industrial and Corporate Change***,** 10-4 861-891.
Frenkel, A (2001) Why high tech firms choose to locate in or near metropolitan regions *Urban Studies* 38 7 1083-1101
Harrison, R and Leitch, C (2010) Spin-off companies, the Entrepreneurial System and Regional Development in the UK *Regional Studies* 44, 9 1241-1262
Hessels J and Terjesen S 2010 Resource Dependency and institutional theory perspectives on direct and indirect export choices *Small Business Economics* 34 203-220
Higher Education Funding Council for England (2009) *Higher education-business and community interaction survey 2008-09* http://www.hefce.ac.uk/econsoc/buscom/hebci/ (March 22 2011)
Huggins, R. (2008). 'Universities and knowledge-based venturing: finance, management and networks in London.' *Entrepreneurship and Regional Development*. 20, 2 March 2008 185 - 206
Iacobucci, D, Iacopini, A, Micozzi and Orsini (2011) 'Fostering entrepreneurship in academic spin-offs' *Int. J. Entrepreneurship and Small Business*
Lawton Smith H. and Ho K. W. (2006) 'Measuring the performance of Oxfordshire's spin-off companies' Research Policy 35, 1554-1568
Lendel, I 2010 'The Impact of Research Universities on Regional Economies: The Concept of University products' *Economic Development Quarterly* 24, 3 210-230
LDA. (2003) London Innovation Strategy and Action Plan http://www.lda.gov.uk/upload/pdf/LondonInnovationStrategyActionPlan.pdf
Lindholm Dahstrand A. (1997) Growth and inventiveness in technology-based firms *Research Policy* 26 331-44
McCann, P & Shepherd, S (2001) 'Public investment and regional labour markets: the role of UK Higher Education' Ch 9 in D. Felsenstein, R. McQuaid, P.McCann and D.

Shefer (eds) *Public Investment and Regional Economic Development* (2001) Cheltenham:Edward Elgar 135-153
Meyer, M (2003) Academic entrepreneurs or entrepreneurial academics? Research-based ventures and public support mechanisms *R&D Management* 33 107-115
Mustar, P., Renault, M., Colombo, M. G., Piva, E., Fontes, M., Lockett, A., Wright, M., Clarysse, B. and Moray, N. (2006) Conceptualising the heterogeneity of research-based spin-offs: A multi-dimensional taxonomy. *Research Policy* 35:289-308.
OECD (2008) *Eurostat-OECD Manual on Business Demography Statistics* Paris: OECD
PACEC (2003) *The Cambridge Phenomenon: Fulfilling the Potential* PACEC, Cambridge
Pfeffer, J. and G. R. Salancik (1978) The External Control of Organizations: A Resource Dependence Perspective. New York, NY, Harper and Row.
Royal Society of Chemists (2006) *Chemical Science Spin-outs from UK Universities-Review of Critical Success Factors* London:Royal Society of Chemists/ Chemistry Leadership Council
Sainsbury (2007). 'The Race to the Top: A Review of Government's Science and Innovation Policies' London: HM Treasury, October
Sassen, S (1991, 2001) *The global city : New York, London, Tokyo* (Princeton : Princeton University Press, 2001) updated 2d ed., original 1991;
Schumpeter, J.A. 1912/1934: *Theorie der wirtschaftlichen Entwicklung*. Leipzig: Duncker & Humblot. English translation published in 1934 as *The Theory of Economic Development*.Cambridge, MA: Harvard University Press.
Shane S. (2006) Academic Entrepreneurship Edward Elgar, Cheltenham
Shapero, A 1984 The Entrepreneurial Event' in *The Environment for Entrepreneurship*, ed. C A. Kent. Lexington, Mass.: D.C. Heath, 21-40.
Smart, R (2008*) Entrepreneurship in the Cultural industries* Unpublished PhD thesis, Birkbeck, University of London
Ulrich, D and Barney JB (1984) Perspectives in organizations: Resource dependence, efficiency, and population *Academy of Management Review* 9 471-481
Vohora A., Wright M., and Lockett A., (2004) 'Critical junctures in the development of university high-tech spinout companies' Research Policy 33, 147-175.
Wood P. (2009) 'Service competitiveness and Urban Innovation Policies in the UK: The implications of the 'London Paradox'' *Regional Studies* 43, 8 1047-1059
Zang J. (2008) 'The performance of university spin-offs: an exploratory analysis using venture capital data' *Journal of Technology Transfer* 34, 255–285