

## **Networks and Spatiality of University Incubators: Global and local links amongst SETsquared spin- off/intra-firms at Universities of Bath, Bristol, Southampton and Surrey in England**

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## Abstract

This paper examines the extent to which university incubators are connected with their regional economy in terms of key resources such as intellectual capital (in the form of new research ideas that have commercial potential), human resource (scientific and industry expertise) and finance. Drawing on network visualisation methods initially pioneered by Casper and Murray (2005), Casper (2007) and Gilding (2008), we analyse patterns of organisational collaboration and clusters among firms which are supported by one of the university incubator programmes in the UK: SETSquared Business Acceleration Centres at Universities of Bath, Bristol, Southampton and Surrey. The study investigates networks at local, national and international levels, identifying the spatial patterns that have evolved in the region since the inception of SETSquared programme in 2003. The paper highlights the significance and persistence of external resource, which is attracted at the local and university level, and makes impacts at the regional level, if appropriate partnership structures are in place. The paper points out the significance of brand-building at the partnership level, which is linked to inter-regional level with strong ties with the wider strong mega-region of Oxford, Cambridge and London.

## Resumen

Este artículo analiza el grado de vinculación que presentan las incubadoras universitarias con su economía regional en términos de recursos clave tales como: capital intelectual (nuevas ideas de investigación con potencial comercial), recursos humanos (especialización científica e industrial) y recursos financieros. Mediante metodologías de visualización de redes, usadas inicialmente por Casper y Murray (2005), Casper (2007) y Gilding (2008), analizamos patrones de colaboración organizacional y clústeres entre empresas que cuentan con el apoyo de uno de los programas de incubadoras de empresas del Reino Unido: *SETSquared Business Acceleration Centres* en las universidades de Bath, Bristol, Southampton y Surrey. El estudio hace un análisis de redes a nivel local, nacional e internacional, identificando los patrones espaciales que se han desarrollado en la región desde la puesta en marcha del programa *SETSquared* en el año 2003. El presente trabajo pone de relieve la importancia y persistencia del recurso externo, atraído a nivel local y a nivel universitario que tiene impactos a nivel regional cuando encuentra las estructuras de colaboración apropiadas. Este trabajo subraya la importancia de la construcción de marcas en el nivel de colaboración, vinculado al nivel interregional con fuertes lazos con la mega-región de Oxford, Cambridge y Londres.

## Laburpena

Artikulu honek unibertsitateko enpresa haztegiek eskualdeko ekonomiarekin duten lotura du aztergai, baliabide gakoei begira: kapital intelektuala (ikerketako ideia berriak, merkataritzako potentziala izan dezaketena), giza baliabideak (espezializazio zientifikoa eta industrial) eta finantza baliabideak. Sareak bistaratzeko metodologiez baliatuz, Casper eta Murray (2005), Casper (2007) eta Gilding-ek (2008) proposatutakoak, enpresen arteko erakunde lankidetzako ereduak eta klusterrak aztertu ditugu, *SETSquared Business Acceleration Centres* programaren babesa duten enpresetan. Programa horren xedea da Erresuma Batuan unibertsitateetako enpresen haztegiei laguntzea eta Bath, Bristol, Southampton eta Surreyko unibertsitateetako errealitatea aztertu du lan honek. Zehazki, tokiko, nazioarteko sareak aztertu dira eta 2003. urtean *SETSquared* programa abian jarri zenetik, eskualdean garatu diren eredu espazialak identifikatzera iritsi da. Lanak agerian uzten du kanpoko baliabideen garrantzia eta eragina, tokiko eta unibertsitateko mailak erakarriak eta eskualdean eragina izango dutenak, bertan lankidetzako egitura egokiak aurkitzen badituzte. Lankidetzan markak eraikitzeak duen garrantzia ere azpimarratzen da, eskualdez gaindiko mailarekin sendo lotuta, kasu honetan, Oxford, Cambridge eta Londresko mega-eskualdearekin.

## **1. Introduction**

Many governments have been interested in creating a basis for high-tech innovation through university spin-off companies and technology incubators (Wright et al., 2006). In the UK, the development of ‘technology based incubators’ originates from an assumption by the government that the promotion of such activity will foster the building of a ‘knowledge-based’ economy that is robust enough to compete in the global market place. The majority of UK technology incubators are supported in full, or in part, by government programmes offering a training ground for entrepreneurs and they are focused on the commercialisation of science and/or technology-oriented applications (Patton, et al. 2009). To fulfil this increasingly important mission, many universities have established university incubators. Universities disseminate their knowledge by multiple routes including licensing, consulting, and by converting new scientific discoveries into technology-based spin-off companies. University spin-offs are believed to have several key benefits: New firms can generate considerable revenue for the institution; make the university more attractive to current and potential faculty members, and benefit the community and the nation (Lerner, 2005).

University technology incubators are expected to play significant roles in the spatial dimension of the spin-off process, as they support networking opportunities by bringing in venture-capital investors from outside the area, negotiating with the university and local government, fostering business culture in a local area, and offering legal and daily business assistance (Peng, 2006). They also attract local people and provide a space to develop a new business with interactions with research at the universities, acting as a ‘knowledge hub’ for the local/regional innovation system (Youtie and Shapira, 2007). As well as aiding spin-off companies on the business side, such incubators can provide a “community and nucleus” for start-up companies (Peng, 2006). In the UK, throughout recent policy support mechanisms to facilitate greater collaboration and interaction between universities and industry (see, Lambert, 2003; Sainsbury, 2007; Wellings, 2008), the development of university spin-off companies has been seen as a favoured route by the government for commercialisation of knowledge from universities in the so called knowledge-based economies (see Patton et al., 2009; Minshall and Wicksteed, 2005).

The focus of the present paper is a yet under-researched area in university spin-off and incubation processes –the spatiality of university incubators and the quality and character of the networks that they initiate. *Spatiality* is important because since the mid-1990s, there has been a growing convergence between the concerns of agencies with responsibility for territorial development and those in charge of the management of higher education (Warren et al., 2010). In an era of globalisation, it is argued that the regional level is of increased attention at a policy level. Both national and sub-national governments are seeking to leverage international knowledge flows to strengthen and contribute to territorial economic development. It is argued that higher education increasingly plays a significant role in “regional networking and institutional capacity building” (Goddard and Chatterton, 1999). Recent studies focus on the role universities can play in supporting innovation-based regional growth, where new mechanisms of university-industry linkages are being forged and various institutional strategies are emerging to integrate the university in new relationships that foster innovation (Lawton Smith, 2007; Kitson et al., 2009; Huggins et al., 2008). In this context, one could argue that universities may fulfill a useful role in blurring the line between these different levels by ‘regionalizing’ world class research and small high technology firm relationships, and by making knowledge available to actors whose innovative locus is much more regional in character. Thus universities as knowledge infrastructures affect the knowledge flows between themselves and other institutions and actors at different geographical scales.

Thus far, much of the debate in economic geography and regional policy concerning the spatiality of these relationships has focused particularly on the interactions between firms and institutions within local groupings or clusters. However, the notion of establishing a ‘geographically defined cluster’ is increasingly seen as problematic (Sunley and Martin, 2003; Asheim et al., 2006) although policy efforts focus on the local and regional level. As Casper (2007) and Gilding (2008) note, the mechanisms by which technology clusters emerge and become sustainable are not well-understood and furthermore, may be highly specific and difficult to predict. A detailed analysis is needed as to how institutions such as firms and universities are interacting and influencing each other; how technology and knowledge are exchanged at different spatial levels (e.g. locally, nationally and

internationally) and what kind of networks and geographical clusters evolve through these processes.

In this paper, we begin to address the gap in understanding the spatial nature of university technology incubators by analysing the networks of firms, both spin-offs and spin-ins, at a structural grouping of university incubators in the UK. Specifically, we study the SETSquared Partnership, a partnership between four universities (Universities of Bath, Bristol, Southampton and Surrey) in Southern England funded through the HEIF. The initiative provides support for very early stage start-ups specifically within the technology sector and that have the potential for high growth. The SETSquared partnership provides a valuable opportunity for such a study, firstly because it was set up relatively recently to engender new networks and we therefore have the possibility to examine developments from initiation onwards; secondly, it is structured across the region, connecting four different universities, a distinctive spatial dimension that provides an extra level of interest and analysis.

Our starting point is to examine the extent to which university incubators are connected with their regional economy in terms of key resources such as intellectual capital (in the form of new research ideas that have commercial potential), human resource (scientific and industry expertise) and finance. Drawing on network visualisation methods initially pioneered by Casper and Murray (2005), Casper (2007) and Gilding (2008), our analysis involves studying patterns of organisational collaboration and clusters among SETSquared firms (Bath, Bristol, Southampton and Surrey) at local, national and international levels, and identifying the spatial networks that have evolved in the region since the inception of SETSquared in 2003. The paper asks the following principal questions:

- At which spatial levels (local, national and international) do SETSquared firms collaborate most? ;
- What are the implications for territorial/regional economic development? ; and
- What are the implications for policy and support for university incubators?

This paper is structured in the following way. Following this introduction, the second section sets the scene by providing recent theoretical discussions to conceptualise university incubator activities and delineating gaps in the existing literature. The institutional context of the SETsquared incubators at the four universities is illustrated against the policy development in the UK over the last decade. Secondly, after presenting our research methodology, we analyse the networks and collaboration patterns between SETsquared firms. We conclude by arguing that there is a need for policy makers at both regional and national levels to recognize the complexity of interactions between the local, national and global levels including firms, universities and ventures, particularly in the early stages of cluster development.

## **2. Theoretical Background and Literature**

In many countries, the need to connect knowledge from universities to wealth creation has become an increasingly important policy agenda. Thus the recent rise in university-industry partnerships has stimulated an important public policy debate regarding the theoretical rationale for government support for knowledge transfer activities (Harman, 2005). University-industry collaboration, commercialization of research results and the protection of intellectual property (IP) emanating from universities have become major policy and research concerns in relation to the promotion of innovation and economic development (e.g. Geuna, 1999; Goddard and Chatterton, 2003; Feldman & Bercovitz, 2006). The UK Government has looked to universities' research as an engine of innovation in the knowledge-based economy (see Lambert 2003; Sainsbury 2007; Wellings, 2008). Consequently, there has been a growing pressure for universities to put more emphasis on transferring and commercializing knowledge from their research; in many cases this has been expressed by the development of technology incubators. However, despite growing interest among academics and policy makers worldwide, there are a number of gaps in the understanding of university-industry linkages, and the relationship between academic science and industrial development (D'Este and Patel, 2007; D'Este and Neeley, 2008).

Research on university-spin offs and/or incubation is one of the rapidly

expanding areas within the broad research field of ‘university entrepreneurship’ or ‘academic entrepreneurship’ (Rothaermel, et al., 2007). Much of the literature concerning ‘the entrepreneurial university’ and ‘academic entrepreneurship’ tends to focus on both exogenous factors (e.g. socio-economic climates and industrial changes, legal frameworks) and endogenous factors including internal transformations within the university and other bottom-up organizational and management changes driven by changes in the IP regimes (Etzkowitz et al., 2008). In order to explain the dynamics of organizational learning and knowledge management practices between university and spin-off firms, authors have examined different factors (e.g. size and R&D of the firm, geographical distance, quality of research, incentive mechanisms), focusing on the faculty, investors, founding teams and external conditions to affect the creation of new firms. Recently, a growing number of studies focus on the networks in which a firm is embedded, examining the network relations of spin-offs or social networks. These works indicate that a developed network of strong relationships with various partners may be an advantage (Walter et al., 2006; Hoang and Antonic, 2003).

The competitiveness of regions can be comprised of “the presence of conditions that enable firms to compete in their chosen markets, and for the value these firms generate to be captured within a region” (Huggins and Johnson, 2009, p.1089). Firms are widely recognized as being embedded in networks of social, professional, and exchange relationships with other actors (e.g., Granovetter, 1985). Institutions are embedded in a social and institutional setting that shapes, and is shaped by, their strategies and structures (Saxenian, 1994). Granovetter (1985) argues that firms are embedded in networks of social and institutional relationships that shape, and are shaped by, their strategies and structures. He argues that economic action is not simply the aggregate of the actions of isolated individuals but is further ‘embedded’ in a set of relationships with various organizations, including customers, suppliers, competitors, universities and public research institutions. These are relationships that are connected with each other and create a wider network structure (Cook and Emerson, 1978; Walter et al., 2006).

In the knowledge based economy, “the capacity and capability to create and innovate new ideas, thoughts, processes, and products and to translate these into economic development” (Huggins and Johnston, 2009, 1090) is seen as key in

underlying the competitiveness of regions, nations, sectors, and firms. The literature and debates in economic geography and regional policies has focused particularly on the interactions of “regional collective learning” between firms and institutions within local enterprise clusters (Keeble and Willkinson, 2000) in addition to the role of regional institutions and social capital in facilitating networking and the generation and diffusion of knowledge (Morgan, 1997; Florida, 1995, Cooke, 2001). The literature suggest that geographical proximity between organisations is important in stimulating dynamic learning and innovation (Malmberg and Maskell, 1999; Porter, 1998) and regional institutions are allegedly expected to actively create a number of economic and social relations to help facilitate a series of institutional interactions (Saxenian, 1994).

Yet Casper (2007) notes that while this argument provides a persuasive explanation for existing concentrations, where a large number of firms coupled with norms and social networks already exist, it does not explain how new social networks emerge in new contexts. As Casper (2007. p441) points out, the social infrastructures supporting technology clusters may be difficult to orchestrate and maintain in a systematic fashion. Casper and Murray (2005) and Casper (2007) highlight the significance of talented specialist scientists and managers in the development of innovative capabilities and performance of the region, who manage the career risks of working in high-risk companies. Building on Saxenian (1994) who argues that a culture of democratised social ties linking scientists and engineers across local companies helps diffuse innovation, it is argued that the career mobility approach explains why many attempts to develop new regional economies fail: while people may initially move from a disadvantage region to a potential cluster development, most clusters, even if they grow initially do not develop the social characteristics of a Silicon Valley, eventually leading to failure of the cluster (Casper and Murray, 2005; Casper, 2007). Casper (2007) identifies the importance of better understanding of how individuals within a region develop the social infrastructure needed to sustain the agglomeration of high risk firms, and notes that this issue has been largely ignored.

These theoretical interests on ‘regions’ and ‘clusters’ have co-existed with the growing importance of ‘non-local’ ties and flows of knowledge. Authors point out that both tacit and codified knowledge can be exchanged locally and globally,



creating certain advantages for those within clusters (see Bathelt et. al., 2004). Recently, however, scholars begin to critically re-examine the concept of ‘clusters’ both in terms of academic analysis and its policy implications (Martin and Sunley, 2003; Asheim et al., 2006). As the globalisation of knowledge, finance and economic flows increases, the cluster’s geographical scope is changing with more tightly woven global production networks, market networks and knowledge networks. This applies to the different spatial expectations regarding the roles of universities. On the one hand, universities are increasingly seen as a strategic part of the local/regional innovation systems. For example, a recent study by the East England Development agency (EEDA, 2010) highlights the importance of what they refer to as the ‘soft company’, based on business models offering local consultancy and contracts based on innovation and knowledge transfer. On the other hand, the internationalization of university-industry relations has been rapidly developing. Etzkowitz (2002) argues that ‘the triple helix’ interaction between university-industry-government is a move towards a new global model for the management of knowledge and technology, where an internationalization strategy emerges within domestic policy structures. Some authors have identified the different spatial nature of university spin-off companies (cited from Benneworth and Charles, 2005):

- 1/ University spin-off companies may be key players in various processes of assembling resources within a regional innovation network and they are sources of entrepreneurs whose technological entrepreneurship can transform the wider regional economy (Etzkowitz, 2001);
- 2/ University spin-off companies build on global technological and client knowledges in building new networks to access finance, sales and marketing (Dahlstrand, 1999);
- 3/ University spin-off companies retain close linkages back to their ‘parent’ institution, through equity holdings incubators, technological transfer, recruitment and research collaboration (Heydebreck *et al.*, 2000).

While these studies have advanced general understanding of creation of knowledge and implications for regional economic development, there are still a number of gaps in our understanding, especially in terms of the processes and spatiality of the networks of spin-offs. Whilst authors underscore the importance of universities in contributing to local and regional economic development, high value jobs and innovation (Etzkowitz, 2001), research outcomes are skewed by a limited number of institutions in the US such as the cases of Massachusetts Institute of

Technology (MIT) and Stanford. Collection of social ties that enable and sustain a highly innovative cluster emerges over time from the collective behaviour of individuals and firms within a regional economy. Findings in Europe suggest that many universities are not experiencing a significant increase in spin-off activities and that few universities have developed ‘social capital’ in terms of their relationship with venture capitals (Wright et al., 2006). Furthermore, as Benneworth and Charles (2005) point out, universities’ greatest successes in regional economic development have been seen in places where all the contextual economic factors are already positive, places that Armstrong (2001 cited in Benneworth and Charles) has characterised as the “totemic sites of the new economy”. This has made it more difficult to isolate and rigorously conceptualise the contributions of university spin-off activities (Benneworth and Charles, 2005), interactions with technology incubators and their spatial nature and impacts. While some regional ambitions have fuelled global influence (Boston, San Diego, Cambridge and Munich for example), as Gilding (2008) notes, there is good reason to question whether this aspiration is realistic.

There is an increasing policy support to develop regional economies through commercialising knowledge from research conducted at universities, and universities are already having a major economic impact through creating spin-off firms on their surrounding areas (e.g. Kitson et al., 2009). However, this does not mean that success will always follow. There is a lack of understanding of the ways in which the ties and connections that are repeatedly identified as so significant emerge, and the conditions in which they develop (see Casper, 2007). Building on these sets of literature, this study contributes to filling this gap. Our study will empirically identify the network and the clusters that the firms have built over the period of the specific incubator programmes, *SETsquared partnership*, thus to detect if the partnership is moving towards sustainability. The SETsquared partnership has invested considerable resource and energy in the incubation of new high technology businesses. In doing so, they have, up to some extent, attempted to build a locally and globally networked innovation system. We examine human, intellectual and financial dimensions of networks of firms in order to analyse the spatiality of firms, in terms of these dimensions, as part of SETsquared incubators. The results will show what level of “technology or knowledge” the SETsquared partnership delivers, at which spatial level, and how the firms respond to the partnership in terms of development and

expansion.

### **3. The SETsquared Partnership**

In the UK, the last decade has witnessed the commercialization of university-generated knowledge taking a stronger role within government policies at a number of levels. Accordingly, a range of national initiatives have been introduced to facilitate greater collaboration and interaction between universities and business, industry, public services and society. A number of funding mechanisms have been put in place, exemplified by the introduction of the Higher Education Innovation Fund (HEIF) funded by the Higher Education Funding Council for England (HEFCE). Consequently, the performance of UK universities in ‘knowledge transfer’, especially the number of university spin-offs, has dramatically improved in the last ten years (HEFCE, 2008; PACEC/CBR, 2009).

SETsquared is a Partnership established in 2002 between four research intensive universities (Bath, Bristol, Southampton and Surrey) in a relatively wide area in South of England, encompassing the South West and South East regions. The SETsquared Partnership was funded following a process of competitive bidding including the HEIF fund, a public initiative in England created to fund innovative collaborative projects between universities for enterprise activities. Since then, SETsquared has had four rounds of HEIF funding and is one of the longest HEIF funded initiatives. The specific objective of the SETsquared Partnership is to provide intense support through the SETsquared Business Acceleration Centres (or incubators) to very early stage, high-tech, high-growth businesses, which would meet both business and policy needs. Between the four institutions, they have about 6,500 academics, and 7% of UK’s research budget in total. The motivation behind forming the partnership is to create a critical mass to compete with the top institutions worldwide, and also ‘the golden triangle’ area of Oxford-Cambridge-London (OCL) with the concentration of the top research universities. Similar consortia have been set up in other parts of England (see Kitagawa, 2004).

SETsquared Business Acceleration supports not only academics in creating university spin-offs, but helps new businesses which come from local business communities (spin-ins). Across the four incubators, on average, 80-90 % of the firms are from local business and the rest (10-20%) are university spin-offs. The majority of the firms have some kind of linkages with the university (see the section below). Between 2002 and 2005 (under HEIF 1), SETsquared supported 144 ventures, equating support for 384 entrepreneurs, far exceeding the target numbers. <sup>1</sup>

SETsquared can be considered to be *a partnership-based brand-building* for cluster development. The Director of SETsquared at University of Bristol describes the value of the partnership as follows: <sup>2</sup>

*It is hugely valuable to the clients, primarily because we get on the radar screen of more investors, professional services firms and so on, which allows us to provide a better service. We also draw on a wider resource pool of incubator expertise, a broader research expertise (~6,500 academics!) and a larger set of investable companies, so that our highly regarded SETsquared Partnership Investment Showcase is of consistently high quality – attracting 150-200 VCs and business angels each year.*

The website emphasises the common platform as a partnership on the home page (see <http://www.setsquared.co.uk/>). In spite of this common branding and overall partnership structure, each SETsquared Acceleration Centre is organised quite differently reflecting the structures and strategies of each university, and their own business models as business incubators. The number of firms in each centre also varies (see Table 1 below). These factors can be related to: a) the way the host university places incubation programme in the university organisation and wider activities; b) the personal background of the incubator manager and his/her approach to enterprise; and c) the nature of technology of the firms at each centre (see Kitagawa and Robertson, forthcoming).

Table 1 Number of firms supported by each SETSquared incubator

Source [www.setsquared.co.uk](http://www.setsquared.co.uk) accessed 10 February 2010

	<b>Bath</b>	<b>Bristol</b>	<b>Southampton</b>	<b>Surrey</b>
<b>Currently supported firms</b>	41	42	25	21
<b>Previously supported Firms</b>	3	10	4	No information available

Between 2006 and 2008, SETSquared participated in the UK's Science Bridges Programme with San Diego, building collaboration with University of California, Irvine and University of California, San Diego, as well as Global Connect programme. The UK's Science Bridges Programme is based on the belief that technology is 'global' from its birth, and by providing research funding rewarding collaboration, the programme aimed to stimulate international enterprise.<sup>3</sup> Under the programme, a number of collaborative research activities were developed between SETSquared and university partners in the US, and private partners were drawn in for commercialisation of the research (see section below for analysis).

#### 4. Methodology

The project is designed to analyse the SETSquared partnership from a spatial point of view. Qualitative, internet-based methods are used to identify and investigate the information flows within the SETSquared system. The methods used are established in the literature (Casper and Murray, 2005; Casper, 2007; Gilding, 2008) where firms are studied in detail on the internet, examining the sources of ideas, people and finance within the firms over time. Using network software, spatial flows of resources in the innovation system can then be modelled and visualised. Idea sources are significant in that they can give some indication of whether a university is engendering innovative growth in its surrounding region. The source of people (as in specialised management teams and scientists) is studied because of the significance of labour flow mobility in the early stages of the development of social networks as shown by Casper (2007). Thirdly, we take a brief look at sources of finance, as

financiers too, as well as providing resource, provide channels and connections beyond their immediate sphere of influence.

A sample of 30 firms from each of the SETSquared Centres was chosen for the study, distributed roughly between the four sites. Data was then collected for each firm from the internet, using the firm's own website and other web links identified by press releases, Google searches on the company name and products and reference to the FAME database (which contains information for companies in the UK and Ireland, <http://www.bvdep.com/en/FAME.html>). The chosen companies were selected for their dynamic growth, their ability to raise funds and their capability in expanding their activities through collaborations and associations. In part this was because the firm's growth trajectory in itself generated a lot of valuable material for analysis. Additionally, the high growth firms, as 'stars' in the early stages could be argued as significant in establishing and shaping the growth of the local innovation system, even if the initial promise was not followed through to continued growth. More specifically, the data collected include information about the firm's genesis and growth through the very early stages of incubation process. The start-up idea was examined, to investigate where the research base for the firm came from (a university department, or a local industry player for example). The senior management team and directorship of each firm were examined, tracking career histories prior to joining SETSquared firms (after Casper and Murray, 2005), to determine from where each firm drew its knowledge "know how" as well as its technological expertise. Additionally, the finance and funding of the firm's (source of finance) was also examined, to determine the source of income for the firms. Finally, each company's collaborations (associations) were explored, to determine how deeply embedded the firm was in local, regional, or other networks.

Initially the stored data was collected in Microsoft Excel. Following a description of "Background-Experience", the "Links-groups" column shows the connections that each manager-director or advisor has, with firms, groups and institutions, beyond their 'home' firm. The "Location", is a spatial indicator of the link between the individual and the connected group, firm or institution, as in "1", local to the SETSquared institution (Southampton based, Surrey based, Bath based, Bristol based), "2" (within the partnership, "3" from the Oxford/Cambridge and

London areas, from Scotland “4”, from the rest of the UK “5” and also from the rest of the World as “6”. The Oxford/Cambridge/London (OCL) and Scotland areas were separated out from the rest of the UK due to their proximity and high ranking research (OCL) or furthest distant within the UK and high ranking research (Scotland). An example is shown in Table 2 below (which has been anonymised for a company non-Exec Chair, AB).

<u>Name - position</u>	<u>Background-Experience</u>	<u>Links-Groups</u>	<u>Location</u> / 1(local), 2 (between B,B,S,S),3 (Ox-Cam-Lon), 4 (Scot), 5 (Rest UK), 6 (World)
AB - Non-Executive Chairman of company	2001 - 2004 President of European company. Currently CEO of European research institute.	1) Dell AB-Sweden - President, 2) SP Technical Research Institute - CEO	<b>6. 6.</b>

Table 2 Example of data table

Tables were then aggregated for each company, as per the example in Table 3:

	<b>50Fold</b>	<b>Camitri Technologies</b>	<b>Smart Sensors Limited</b>	<b>The Retention People</b>
<b>Local</b>	1	0	0	0
<b>Southampton-Surrey-Bath-Bristol</b>	1	1	0	1
<b>London-Oxford-Cambridge</b>	0	0	0	0
<b>Scotland</b>	0	0	0	1
<b>Rest UK</b>	0	0	0	6
<b>World</b>	0	0	0	2

Table 3 Example aggregate table

Table 3 shows the number of connections that each firm's management / directorship has using the schema exemplified in Table 1, that is locally, between Bath, Bristol, Southampton and Surrey, at the areas of "Oxford, London and Cambridge", connections from Scotland, from the rest of the UK and World. To visualise the data, <http://www.analytictech.com/Netdraw/netdraw.htm> was used to identify and study patterns of organizational collaboration and clusters among SETsquared (Bath, Bristol, Southampton and Surrey) firms at a local, national and international level. Netdraw is a package designed to handle social network data in this form.

Inevitably of course, while every effort was made to be consistent in the collection of the data, there are inevitably weaknesses in our strategy. Firstly, many young companies post little information about themselves in the very early stages of development. Firstly, we investigated those firms that were highly visible, which may introduce bias into the results. Secondly, managers/advisers who were influential in the very early stages of company development and then left may have been missed. Similar considerations apply to collaborations. Thirdly, firms vary in how they define senior management roles, or other key personnel, and also in the amount of information they provide about the roles. We did include all those we could identify as being members of the senior management team, or highly influential personnel. Again, similar considerations apply to collaborations. Fifthly, we do not know the effect to which connectivity implies influence. While recognising these effects, we do not feel that they impact strongly on our network constructions and visualisations as we are looking for overall patterns and directions of connectivity, not precise network analyses.

## **5. Analysis**

The first analysis traced the origin of the initial commercialisation research: the 'home University (Bath, Bristol, Southampton and Surrey), or another location. This is shown in Diagram 1 below:



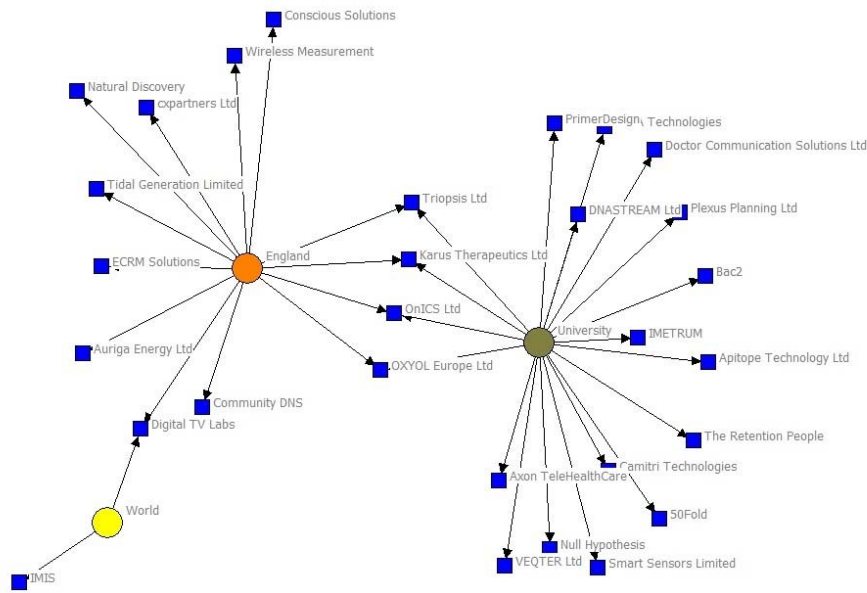


Diagram 1: Knowledge source

This shows, not surprisingly, that the majority of SETsquared partnership firms, 66.3%, have strong ties with the local university in terms of the knowledge base. This does not mean that they were spin-offs necessarily, but that is some way a clear linkage could be made between the firm and a research group. For example, a research student may leave the university, start a firm outside the university later on based on their research and then return for incubation to the university at a later date. Some ideas were generated in England and outside the UK, but none had come in from Scotland or OCL (presumably collaborating with their own well-developed local incubators). The SETsquared partnership is soundly grounded in the local/regional knowledge base.

The second analysis identify the management links of the firms with the locations schema to identify the source of the management and directorship expertise. This is shown in Diagram 2.

Diagram 2: Management and Directorship

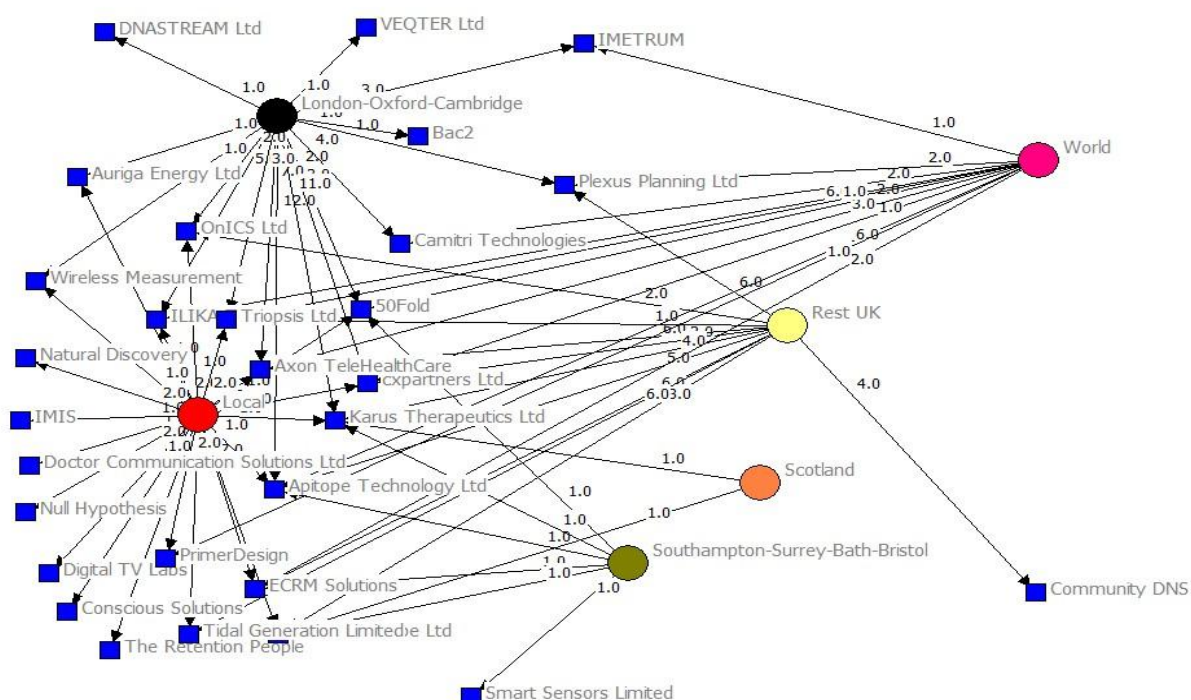
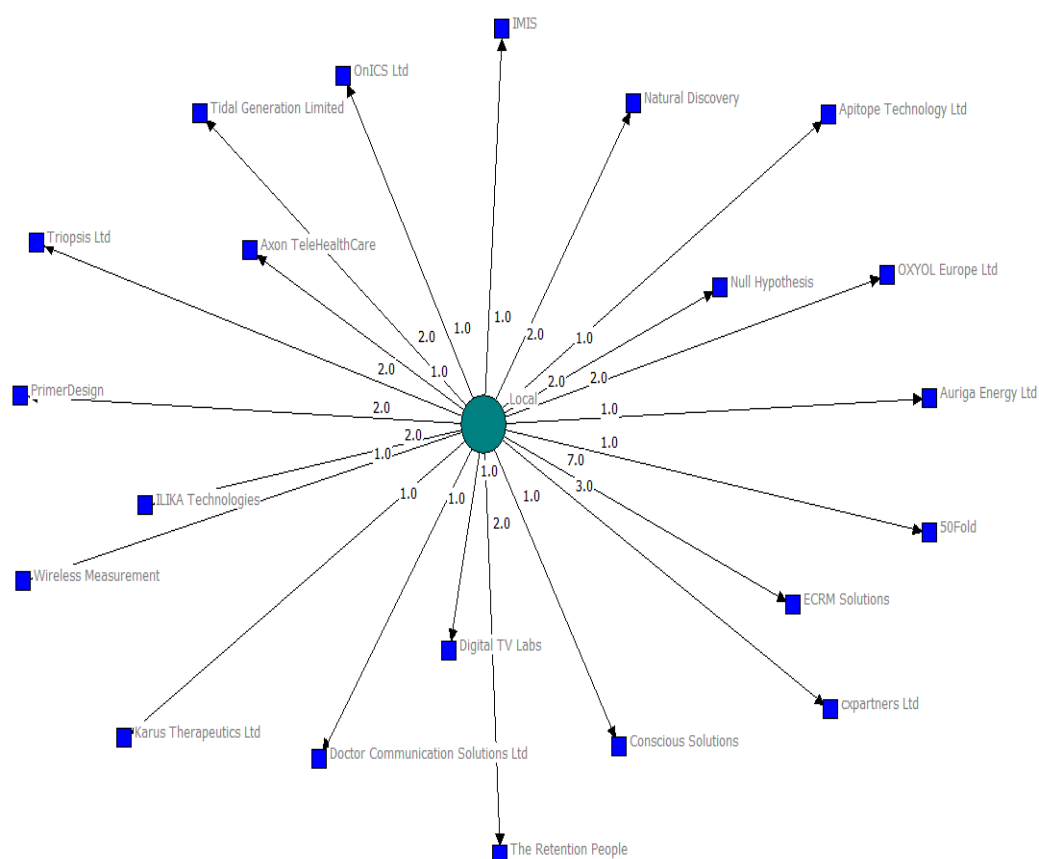


Diagram 2 shows that the “Local” and “Oxford – Cambridge and London” areas are the main sources of expertise in the SETsquared partnership, followed by the rest of the World, the rest of the UK and between the partnership (Southampton, Surrey, Bath and Bristol) and Scotland, which plays a minor role to the particular analysis. 21 of the 30 firms have managers from their local area, connected to either the firm or the university. Over half (55%) of 30 firms have senior managers or directors from OCL, with Cambridge featuring very strongly. It is not surprising that management expertise features strongly in the partnership given its strength as a high technology centre in the UK (Druihe and Garnsey, 2000; Casper and Murray, 2005).

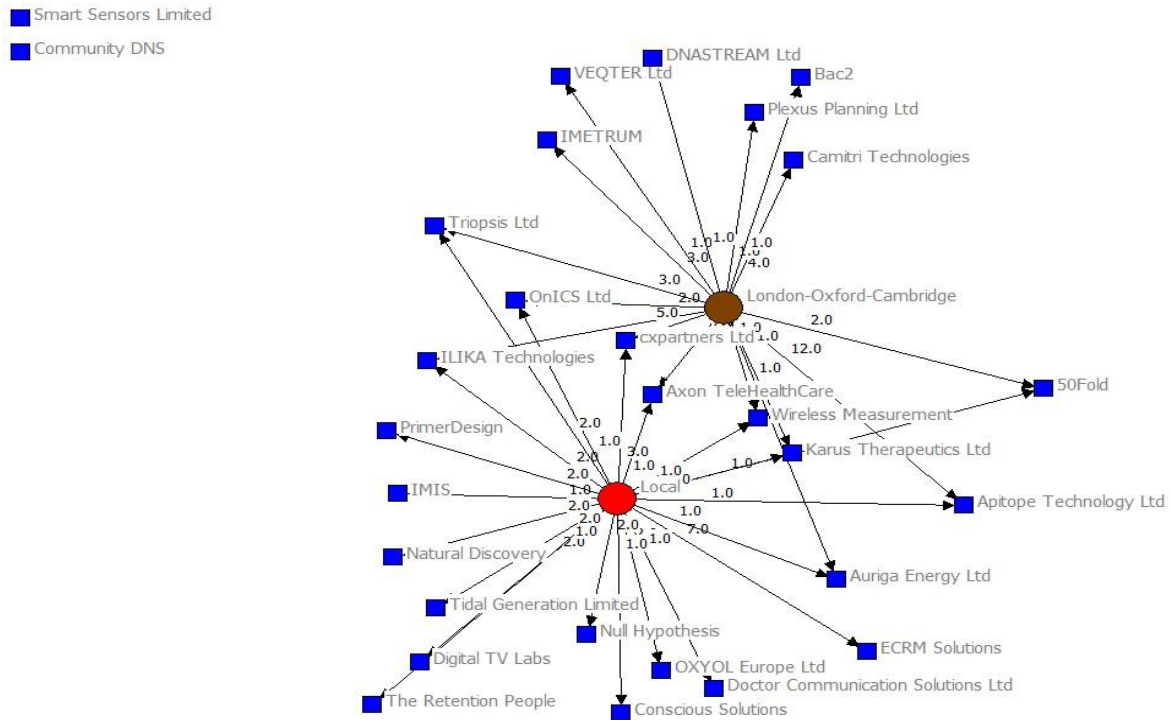
Firms with predominantly local connections are highlighted in Diagram 3 below

Diagram 3: Management and Directorship (Local)



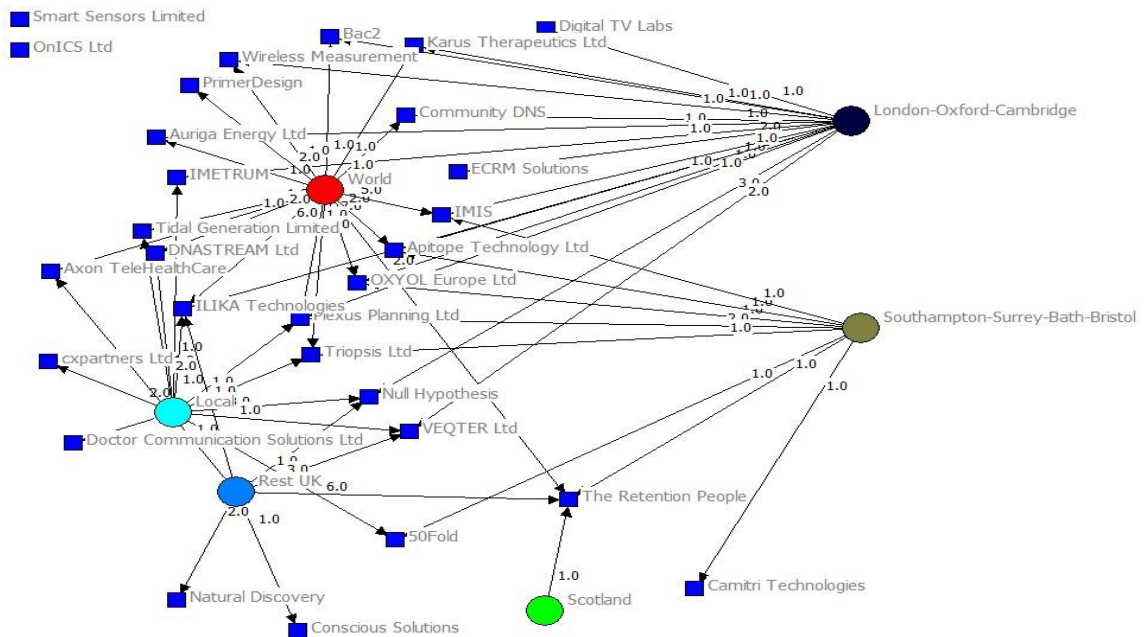
And for OCL, Diagram 4 below:

Diagram 4: Management and Directorship (Local and Oxford – Cambridge and London)



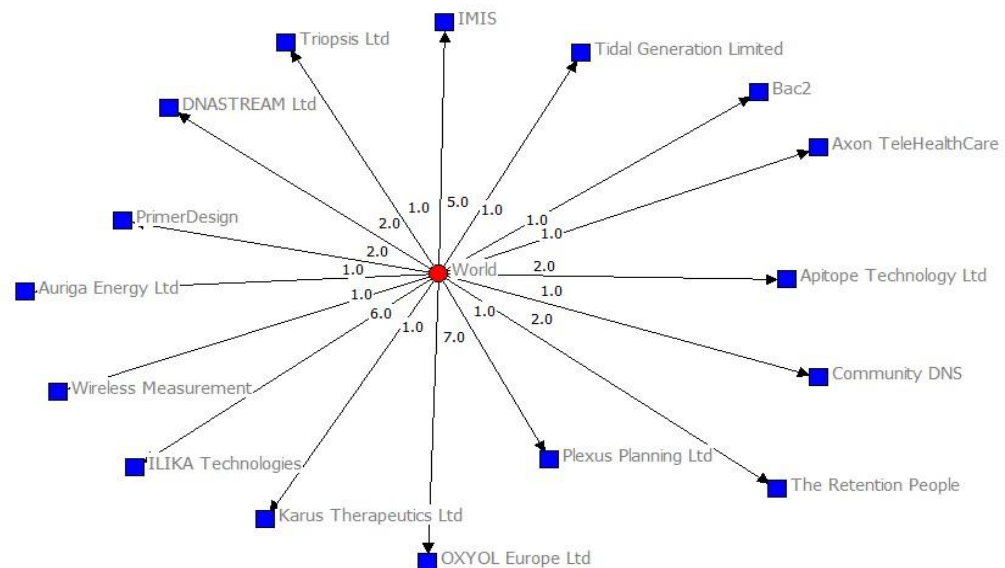
The third analysis examined the collaborations that the SETsquared firms have, with firms, institutions and corporations, again using the locations schema. This is shown in Diagram 5 below:

Diagram 5: Collaborations



This clearly shows that the partnership is well connected internally and beyond its local region, the San Diego Bridges partnership being influential here in the ‘world’ category, as shown in Diagram 6 below:

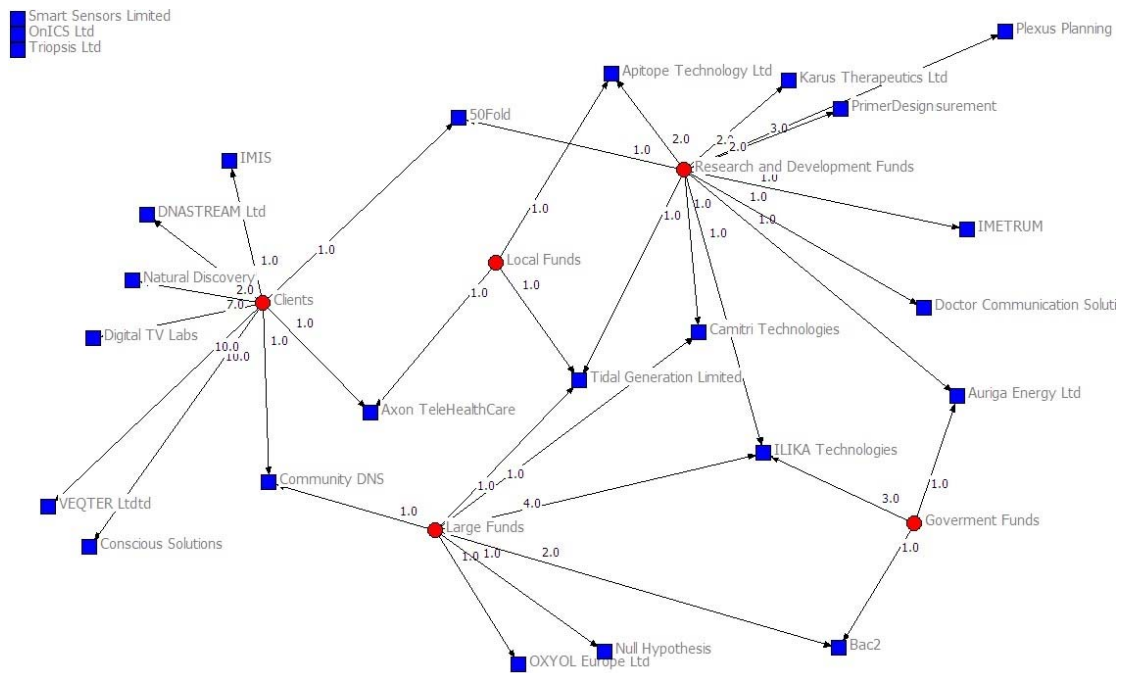
Diagram 6: Collaborations (World)



The fact that 57% of the firms are connected to the area “World” is in part based on strong relations the SETsquared partnerships has, with the Universities of California San Diego, California Irvine “Science Bridge program” and additionally, the Bridge linked into the San Diego CONNECT Programme.

The final analysis is to examine the flows of finance and funding acquired by the SETsquared firms examining the categories “research and development”, “large funds”, “local funds”, “government funds” and “clients”, as shown in Diagram 7.

Diagram 7: Funding and Finance



The majority of the firms (90%) at the time of the analysis had received little funding from R&D sources such as SULIS (a regional seedcorn fund) and Government SMART (now R&D) awards, or from consultancy, reflecting their early stage of development. Some ‘star’ firms had though, been more successful in generating funds from national and international VC/Angel funds, often administered in London.. However, overall, as Pinch and Sunley (2009) note, there is still little established VC infrastructure in the region.

## 6. Discussion

The SETsquared incubators are certainly perceived as successful having spawned and supported a good number of new technology firms. As expected, many of the firms are still in the incubation phase and are reliant on very early stage R&D funding, consultancy and client relationships, but some are well on the way to significant growth and/or flotation, having acquired considerable funding from outside funders. In the main, firms have remained close to home in terms of their local university partner/research base. Indeed they have also relied on management expertise from around the local area, but our data also shows there has been heavy

reliance on external expertise, mainly from OCL, but also from the San Diego connection. Thus far we have identified patterns of collaboration that indicate a stream of knowledge transfer from OCL, 'golden triangle' of research excellence in the UK, to SETSquared. Strong webs of linkages and affiliations have continued from prior the incubator set-up in 2002 and seem to be persisting.

Returning to the summary of spatial types cited in Benneworth and Charles (2005), we can see evidence of all three categorisations in the early stages of SETSquared, which raises interesting possibilities as to the eventual trajectory of the cluster.

- Type 1 University spin-off companies as part of a regional innovation network
- Type 2 University spin-off companies as part of global knowledge networks
- Type 3 University spin-off companies close to their 'parent' institution

We see (Type 2), where the spin-offs build on global knowledge bases in building new networks (Dahlstrand, 1999). It is too early to say whether this is an influx of 'cluster start-up' capital that will diminish as resources begun to be locally generated. If there was a decline of imported capital, and the cluster continued to be successful, then there would be a progression to the healthy kind of regional innovation network suggested by Etkowitz (2001). Of course, it may not be either/or – perhaps the future holds an ongoing dynamic two-way process of knowledge exchange between the regional (SETSquared), the national (OCL) and the international (especially, in the latter case, given the Bridges programme has ended). Of course that would raise the question of how this is to be funded. Also, we see Type 3 (Heydebreck et al, 2000), where the firms thus far have stayed close to the home university, in terms of resourcing and ongoing connection. This will be an interesting story to follow as it has implication for how public money is targeted at new areas: what is the long-term future for imported capital, if it is a necessary condition for success, how do clusters attract and develop it, and how long should public support of that kind of involvement persist? Thus far, after Heydebreck et al (2000), SETSquared success has been concentrated on the local university region, rather than at the overall partnership level: there is not much evidence of such strong ties between the partner institutions but there may be looser informal ties that are also valuable that we have not investigated during this study (see Kitagawa and Robertson, forthcoming).

Through cross-regional partnerships such as SETsquared, the following institutional value can be created:

- fostering a sense of competition and performance measurement across the institutions, through connection, collaboration, shared events; and
- building a brand, 'SETsquared', that looked 'big', fostering trust for resource building by OCL connections, access to four for the price of one.

This partnership-based brand-building for cluster development has received little study thus far. Staber (2010, p.168) points out that the processes of identification with and within clusters are subtle and not well understood, and suggests that identification with clusters may not be driven by close social interaction as is often assumed in the cluster literature. A systematic concern for the micro-foundations of cluster identity opens up opportunities for research on the construction of collective representations with which the actors interpret, respond to, and shape their competitive environment. This is important if the partnership model is exported to other areas, and would require further investigation.

This idea of 'brand-building' through the development of a reputational ecosystem again would be a useful area for future research. We have identified four characteristics that might contribute to such brand-building and that are worthy of future study:

- the existence of an identifiable 'brand' such as 'SETsquared', that fosters a sense of size, significance, presence, common reporting and influence;
- the potential connection to individuals of high techno-entrepreneurial capital, through the partnership itself [in this case, four high-quality universities for the price of one];
- bridging programmes that [in the early stages at least] explicitly connect the proto-cluster to other regions, nationally or internationally; and
- Successful companies! This is of course, paramount!



Picking up on the last point, without the success of its companies, a cluster is doomed and discussions of sustainability are pointless. Clearly, ‘star’ companies that emerge early on the stages of a new partnership and attract large amounts of VC funding and aim at flotation tend to attract media attention at the national and international level. This must be important. Yet EEDA (2010) tells us that we should not neglect the significance of the firms that grow slowly through regional-based consultancy and client contracts. This combination of high profile stars, together with ‘bread and butter’ incubation, and its role in developing the reputational ecosystem central to brand building is an interesting avenue for further research.

## **7. Conclusions and policy implications**

Recent studies focus on the network relations of spin-off firms or social networks those firms are embedded in. These works indicate that a developed network of strong relationships with various partners may be an advantage. University technology incubators are expected to play significant roles in the spatial dimension of the spin-off process, as they support networking opportunities by bringing in venture-capital investors from outside the area, negotiating with the university and local government, fostering business culture in a local area, and offering legal and daily business assistance, thus creating social capital for firms and the university. In order to analyse the spatiality of spin-off firms, we examined networks of firms as part of SETsquared Business Acceleration Centres at Universities of Bath, Bristol, Southampton and Surrey in England. The results show what level of “technology or knowledge” the SETsquared partnership delivers, at which spatial level, and how the firms respond to the partnership in terms of development and expansion.

Literature suggests that geographical proximity between organisations is important in stimulating dynamic learning and innovation, and regional institutions are allegedly expected to actively create a number of economic and social relations to help facilitate a series of institutional interactions. Casper (2007) argues that better understanding of how individuals within a region develop the social infrastructure and sustain the agglomeration of high risk firms is significant in explaining the emergence and development of clusters. This study has focused on the knowledge, human

capital, information and finance flows that have taken place during the establishment of a new partnership based on a regional cluster. Drawing on network visualisation methods initially pioneered by Casper and Murray (2005), Casper (2007) and Gilding (2008), we analysed patterns of organisational collaboration and clusters among firms which are supported by the collaborative incubator programme between the four universities.

Our study has value because we have captured the cluster at a very significant time of its development, when considerable success has been demonstrated, but the expectation is now that public funding will decrease as the gestation period is over. Through our analysis, multi-level dimensions of organisational strategies and co-evolution of multi-spatiality in cluster development are illustrated. Our main findings further demonstrate key two points. Firstly, the study shows the significance of the *imported* human and financial resource brought in to support the development of *local* knowledge bases such as university incubators. Secondly, our findings identify the processes of the amplification of local resources through cross-partnership brand-building. These two issues are of course closely interlinked.

One fundamental question remaining for further research is whether SETsquared has over time, accelerated a nascent winning region to a sustainable cluster in its own right through the stimulus of imported resource. There must surely be a balance between the knowledge and structural resources in a region and the likelihood of external interest. In other words, from a public policy and management perspective, critical policy questions arise as follows:

- Which regions should policy-makers choose that are strong enough to have the potential both for acceleration and external interest?;
- How much money would have to be put in to generate that external interest?;
- and
- How long would universities and regional agencies have to support these interactions through partnership and international bridge-building partnerships such as the Bridges initiative?

As Casper (2007) points out for the San Diego cluster, the critical ties linking senior managers within the region were formed primarily through shared market experience. Somewhat worryingly, he argues that it was quite a rare event that catalysed tie formation in San Diego, specifically a failed acquisition of a highly successful company: in which case, he concludes, the creation of social structures capable of supporting such developments may be outside the purview of direct government policy. We would agree that more research investigating how policy supports the formation of shared market experience and social ties within emerging high technology clusters.

In summary, we set out to establish the spatial character of the SETsquared network, at what levels, namely, *local*, *national* and *international*, has collaboration taken place. There is a need for policy makers at both regional and national levels to recognize the complexity of interactions between the local, national and global levels including firms, universities and ventures, particularly in the early stages of cluster development. We uncovered some important questions for future research that have implications for future regional/territorial development. These questions are focussed on firstly, the significance and persistence of external resource. While further research is needed, it seems most likely that while it is deployed at the local, university level, external resource is attracted by, and impacts at the regional level if appropriate partnership structures are in place. Secondly the amplification may well be linked to brand-building at the partnership level, which is linked to inter-regional level with strong ties with the wider strong mega-region, namely, Oxford, Cambridge and London. This notion of amplification is significant for policy makers and for universities seeking to increase their impact.

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