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**DO CLUSTERS REALLY MATTER FOR INNOVATION PRACTICES IN
INFORMATION TECHNOLOGY? QUESTIONING THE SIGNIFICANCE OF
TECHNOLOGICAL KNOWLEDGE SPILLOVERS**

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Abstract:

A widespread assumption in economic geography and the economics of innovation is that firms located in clusters benefit from territorial learning and (technological) knowledge spillovers. However, there have been few empirical investigations of potential mechanisms, and it remains unclear to what extent these benefits actually occur. This paper aims to address this issue and examines to what extent research and development (R&D) workers in the Cambridge Information Technology (IT) Cluster benefit from being located in the Cluster. Grounded in interviews and a survey with 105 R&D workers in 46 innovation-based firms, the empirical results challenge some of the prevalent views. The results show, first, that many R&D workers do not believe that their work benefits from being located in the Cluster, and the reasons for this are explored. Second, the importance of personal knowledge networks is limited, and the majority of those extra-firm personal networks that do exist are non-local. These results suggest that academics as well as policy makers need to be more careful with the assumption of technological knowledge spillovers in innovative clusters. Finally, the paper discusses that the significant advantages of the Cambridge IT Cluster for R&D workers are of a different nature: in particular they concern labor market advantages and benefits from the global 'brand' of Cambridge.

Do clusters really matter for innovation practices in Information Technology? Questioning the significance of technological knowledge spillovers

Franz Huber (University of Cambridge)

1. Introduction

It is widely accepted that acquiring external knowledge is crucial for the success of firms, particularly in the creative and high-technology industries (Pittaway et al., 2004). In the literature on regional learning and innovation it has been argued that firms located in clusters benefit from other co-located organizations that create local knowledge spillovers. Within this context it is now almost taken for granted that local formal and informal networks are crucial for knowledge flows and regional competitiveness (e.g. Camagni, 1991; Keeble, 2000; Saxenian, 1996). However, it is surprising that despite the vast amount of literature on this topic, there is still very little empirical evidence on the mechanisms of local knowledge spillovers and the role of personal networks for knowledge flows. Many assumptions in the literature actually remain untested as highlighted, for instance, by Breschi and Lissoni (2001a) or Döring and Schnellbach (2006).

The aim of this paper is to critically engage with the assumed innovation benefits of clusters by focusing on research and development (R&D) workers – including Technology Managers and Managing Directors in micro businesses – in one of Europe’s most prominent high-technology clusters, the Cambridge Information Technology (IT) Cluster. This paper investigates whether R&D workers experience knowledge benefits from being located in the Cluster and, fundamentally, whether and how the Cluster matters. The results challenge some of the widespread beliefs in the literature. They show that technological knowledge flows within the Cluster seem highly limited, and many R&D workers do not believe that their work benefits from the Cluster. The significant advantages of the Cluster are of a different nature; in particular they concern labor market advantages and the global ‘brand’ of Cambridge.

This paper proceeds as follows. Section 2 will critically discuss the existing literature on knowledge spillovers and knowledge networks in economic clusters,

and it will highlight open questions. In section 3 the research design and methodology of the case study will be presented. Section 4 will address the question whether the Cambridge IT Cluster really matters for innovation practices of R&D workers. It will be shown that for many this is not the case and the reasons for this will be examined. Afterwards, section 5 it will be demonstrated that the role of personal networks is limited, and those networks that do exist are strongly non-local. Section 6 will explore in which respects the Cluster is beneficial. Section 7 will conclude.

2. Innovation advantages in economic clusters: technological knowledge spillovers and knowledge networks

In this section, first, arguments of territorial learning and local knowledge spillovers and their limitations are examined followed by discussions of knowledge networks and spatial proximity. Afterwards, the key questions raised in the literature are linked to the research questions of this paper.

2.1. Territorial learning and local knowledge spillovers

It is a popular idea that firms located in clusters benefit from local knowledge spillovers: knowledge created by a local agent can be accessed and used by other agents without market interaction and financial compensation for the producer of the knowledge.¹ In particular, in much of the literature on this topic, this concerns technological knowledge generated through research and development.² It is a widespread belief that knowledge flows freely within co-located organizations as a local public good (Breschi and Lissoni, 2001a). This is widely regarded as a source of regional economic growth and as a causal reason for the emergence of agglomerations (Döring and Schnellenbach, 2006).

Most *territorial innovation models*, including concepts such as innovative milieu, industrial districts, clusters, regional innovation systems, and the learning region (see Moulaert and Sekia, 2003), propose that territorial learning and local (technological) knowledge spillovers are an important agglomeration and innovation

¹ This definition does not regard unintentionality of knowledge flows as a necessary condition because knowledge can be intentionally transferred to other organizations informally. Also, this definition does not include cases of so-called rent externalities where less compensation is given than the market value of the knowledge (Caniels and Romijn, 2005, 499).

² In this article, I differentiate between technological knowledge spillovers, used interchangeably with technological spillovers, and knowledge spillovers, which refer to a broader class of knowledge (including business knowledge).

force. Most approaches concentrate on local socio-cultural pre-conditions for knowledge to diffuse effectively within co-located actors (e.g. Camagni, 1991; Capello and Faggian, 2005; Lawson and Lorenz, 1999; Storper, 1997). Within this context, it has often been claimed that the nature of tacit knowledge, knowledge which is highly contextual and difficult or even impossible to codify (Gertler, 2003), is decisive (Breschi and Lissoni, 2001b). Because it requires direct face-to-face interactions, regular co-presence and a shared local social context, the transfer of such tacit knowledge is assumed to be highly localized (Feldman, 1999; Maskell and Malmberg, 1999).

Although increasingly multi-scalar knowledge sourcing and ‘global pipelines’ have been highlighted, current debates still often involve similar ideas on local knowledge flows: Taking up the idea of Marshall’s ‘industrial atmosphere’, the neologism local ‘buzz’ (Bathelt et al., 2004; Storper and Venables, 2004) and ‘noise’ (Grabher, 2002) have been introduced recently. A key characteristic of these concepts is that actors in clusters “are automatically exposed to news reports, gossip, rumours and recommendations about technologies, markets and strategies by just being in the cluster” (Bathelt, 2005b, 206).

Furthermore, there have been more empirically oriented approaches of ‘new economics of innovation’ (Audretsch and Feldman, 2003; Feldman, 1999) which have emphasized the importance of local technological knowledge spillovers. Here, so-called knowledge production functions (Audretsch and Feldman, 1996) or patent citations (Jaffe et al., 1993) have been used and proposed as indirect indicators of technological spillovers.

However, these assumptions usually have not been developed on the basis of rigorous empirical work on the processes of learning and knowledge spillovers. Usually without investigating specific mechanisms, firms located in clusters are assumed to benefit from hypothesized knowledge spillovers (Malmberg and Maskell, 2002, 434). Also, ironically the meaning and functioning of ‘tacit knowledge’ usually remains tacit (Martin and Sunley, 2003, 17).

The recent focus in economic geography on ‘local buzz’ does not clarify this aspect but rather reinforces the shortcomings. No definition of buzz unambiguously states which social processes are included or excluded in ‘local buzz’ phenomena, face-to-face interactions and buzz are conflated (Asheim et al., 2007), and it remains unclear whether and how knowledge quasi-automatically travels among local actors (Moodysson, 2008). Thus, the actual processes of territorial learning usually remain unexplored (Benner, 2003, 1810; Oinas, 1999; Staber, 2009). A major reason for this

is that the focus on inter-firm knowledge activities tends to neglect personal, and often informal, relationships of individuals; this is the level where the mechanisms of learning actually take place (Malmberg and Power, 2005, 421). With a few exceptions (in particular Benner, 2003; Dahl and Pedersen, 2004; Grabher and Ibert, 2006; Henry and Pinch, 2000; Ibrahim et al., 2009; Kesidou et al., 2009; Lissoni, 2001; Østergaard, forthcoming; Saxenian, 1996) the literature does not look closely at cross-firm knowledge links beyond the firm-level and formal linkages.

Furthermore, although the elaborate methodological approaches in economics of innovation have thrown some light on the geographical foundations of knowledge production and innovations, they are even more silent about processes of knowledge flows. Because they use indirect indicators, the knowledge production function approach and the patent citation approach are not able to investigate the concrete mechanisms of local technological spillovers (Breschi and Lissoni, 2001a; Döring and Schnellenbach, 2006; Henderson, 2007). Even the most fine-grained recent economic studies on technological spillovers such as Zucker et al. (1998) use crude proxies such as co-authorship to represent more complex and diverse social relationships and processes.

My paper contributes empirically to the literature on individual-level learning, and the results challenge widespread assumptions of the importance of technological knowledge spillovers.

2.2. Networks of knowledge flows

One of the key themes in the above-mentioned literature is that networks matter. As part of the ‘relational turn’, all of the territorial innovation models emerging in the 1990s underlined the importance of relationships between firms and organizations for regional economic development (Boggs and Rantisi, 2003, 109; Grabher, 2006, 164). The dominant picture is that

“[...] successful technology based clusters are invariably characterized by active and relatively intense local networking, involving the exchange and development of new knowledge and enhanced collective learning between local firms and organizations” (Keeble, 2000, 214).³

Empirical studies that do not find extensive networks in clusters, tend to argue that this is an undesirable situation which is causally responsible for the lack of success of clusters (e.g. Bathelt, 2005a).

³ Breschi and Malerba (2001, 819-20) arrive at a similar conclusion.

Often, for instance, in Porter's (1998) work on economic clusters, the role of social networks for clusters is emphasized but the specific mechanisms are not rigorously theorized and empirically investigated (Martin and Sunley, 2003, 16-7). One reason for this is that the discourse has tended to privilege inter-organizational networks at firm-level at the neglect of inter-personal networks across organizations (Grabher and Powell, 2005, xxiii). Also the recent innovative network analyses by Giuliani (2007) and Boschma and ter Wal (2007) are based on the firm-level.

The literature on individual-level networks in economic geography that does exist leaves open questions. Often the studies discuss and operationalize the idea of external personal networks in unspecific terms such as 'implicit co-operation' (Capello and Faggian, 2005, 80), which does not reveal processes of interaction and knowledge flows. Saxenian's work on Silicon Valley is arguably one of the most prominent and illuminating contributions highlighting the importance of inter-firm mobility, personal networks and meetings at professional events for knowledge transmissions (Saxenian, 1996). However, the study does not clarify which types of resources actually flow in which contexts and how widespread this is. The following studies lead to a more detailed understanding: Grabher and Ibert (2006) present a sophisticated typology of personal networks and elaborate on their role in the Hamburg advertising and the Munich software business. Moodysson (2008) shows that in the Swedish Medicon Valley life science region carefully selected, potentially global, informal networks are important for problem-solving activities but unstructured local buzz seems largely absent. However, these studies do not focus in detail on the level of importance and pervasiveness of extra-firm networks for individual knowledge workers; moreover, the role of local clusters and technological spillovers for knowledge workers remain underexplored.

Furthermore, the geographical literature usually ignores the insights of the business and management literature into personal knowledge networks. In particular, studies on informal 'know-how trading' (Carter, 1989; Sattler et al., 2003; Schrader, 1991; Von Hippel, 1987) highlight that informal networks among technical workers or managers can lead to reciprocal knowledge flows between firms (and even competitors). However, these studies do not thoroughly investigate which type of knowledge is actually exchanged and what spatial dimension they involve. As one of the most detailed studies, Dahl and Pedersen (2004; 2005) reveal that engineers in the wireless communication cluster around Aalborg have frequent contacts with each other, which often leads to the receipt of useful work-related knowledge. However, their paper does not examine the value of the transmitted knowledge, and it does not investigate non-local networks.

The contribution of this paper is to systematically examine the actual importance of extra-firm personal knowledge networks for innovation practices in IT. Contrary to prevailing views, it will be shown that in a successful cluster their significance is limited.

2.3. Spatial proximity and beyond ‘islands of innovation’

Most traditional relational accounts in economic geography have focused on how *local* relational assets influence regional economic development. Increasingly the literature has questioned the concentration on the local level only and called for a wider spatial focus integrating extra-local networks (e.g. Amin and Cohendet, 2004; Bathelt et al., 2004; Bunnell and Coe, 2001; MacKinnon et al., 2002; Yeung, 2005).

Beyond conceptual discussions, a few empirical studies suggest that extra-local knowledge relations are important for learning and innovation in clusters. For instance, the innovative study by Giuliani and Bell (2005) showed, firms in clusters that are ‘gatekeepers’ are critical for the acquisition of non-local knowledge. Furthermore, an earlier survey on high-tech firms in Cambridge (UK) revealed that sources of innovative activities (suppliers, clients, competitors, consultancy firms and higher education institutions) outside the Cambridge region were regarded as more important than sources within Cambridge; moreover, more collaborative research activities were with firms in the UK or abroad than with local ones (Keeble et al., 1999; Keeble et al., 1998). Thus,

“[I]ocal and global innovation networks thus appear to be of simultaneous – and probably complementary – importance for the competitive success and growth of regionally-clustered technology-based SMEs” (Keeble, 2000, 218).

That is, the multi-scalar perspective does not seem to imply that local knowledge networks and spillovers are insignificant (see also the ‘local buzz and global pipelines’ metaphor).

All these contributions are based on the firm-level and do not focus on knowledge flows through personal networks. A prominent exception in this respect is the recent work of Saxenian (2006) that illustrates the importance of transnational personal networks of engineers and entrepreneurs for regional development. Yet even here, “one wishes for more precise statements of [...] the precise nature of what these networks do in sociological and economic terms” (Storper, 2007, 114). Furthermore, Grabher and Ibert (2006) and Moodysson (2008) empirically illustrate multi-scalar spatial configurations of personal networks.

Overall, the role of geographical distance in knowledge transmissions is still unclear (Döring and Schnellenbach, 2006, 388-9). More empirical studies are needed to gradually arrive at a more systematic understanding of the spatiality of personal knowledge networks in different industries, knowledge bases and job positions.

My paper contributes to this collective effort and demonstrates that those extra-firm personal networks of R&D workers in IT that do exist are highly located outside of the Cluster.

2.4. Research questions

This paper aims to address the voids discussed above by being one of the first papers that systematically examines R&D workers and their experiences of a cluster. The guiding questions are: (i) To what extent and how does being located in the cluster matter for R&D workers. (ii) Specifically, to what extent do R&D workers benefit from local knowledge spillovers and knowledge networks within an innovative cluster?

3. Case study and research design/methodology

In this paper the term 'cluster' refers to a geographical agglomeration of firms operating in related industries; to what extent in reality relationships and knowledge interactions occur is an empirical question but not part of the definition.⁴ Within the Cambridge IT (Information Technology) Cluster, high-technology firms of the sub-sectors hardware and software were randomly selected. In each firm R&D workers were chosen as the embedded unit of analysis.

Cambridge is used as a case study because it is widely regarded as one of the most innovative and successful high-technology region in the UK and the EU (Simmie et al., 2006). The existing literature suggests that in such successful clusters vibrant knowledge flows are going on. Therefore, Cambridge represents a prime example where the theoretical assumptions of local knowledge spillovers and inter-firm knowledge flows can be scrutinized.⁵

⁴ For a similar approach and a useful discussion of different theoretical concepts see Giuliani (2005).

⁵ Saxenian remarked in the late 1980s that the tenants of the Cambridge Science Park complain that there is hardly any information sharing or co-operation among firms (Saxenian, 1989, 468-9). However, after a vibrant development in the last decades and more recent studies about Cambridge, nowadays the dominant belief is that local interaction and knowledge flows between firms are indeed

The IT sector is used as an empirical focus because it constitutes the dominant sector of the ‘Cambridge phenomenon’ in terms of the number of innovation-based businesses (LibraryHouse, 2004). Within IT, this study looks at the dominant product-based sub-sectors hardware and software (excluding purely service-based companies).

The focus on R&D workers in various job positions – from junior developers, Chief Technology Officers to Managing Directors in micro firms – enables a direct investigation of the knowledge sourcing experiences. Asking managers only would lead to partial and potentially incorrect views because they do not necessarily know what employees are really doing, and their views are likely to be biased towards the official ideal strategy of the firm (see e.g. Dahl and Pedersen, 2005, 76).

The population at firm-level consists of 220 firms, 156 in software and 68 in hardware, in the Greater Cambridge Region. The sample is constituted by first taking a random sample of 100 firms (70 in software, 30 in hardware). Within those I asked the firms to select R&D workers according to the following criteria (if applicable): the Managing Director if s/he is actively involved in research or development; the Director of Research or Development or Chief Technology Officer; one ‘key’ engineer/developer who is regarded as most important for the firm; one senior engineer/developer (e.g. project leader); one mid-level engineer/developer; one junior engineer/developer with less than two years of work experience in the industry.

It has to be emphasized that getting access to the firm was incredibly difficult. After 11 months (January-November 2008), data from 105 individuals in 46 firms were collected, which represents a response rate of 46% of the firms in the sample. 58 individuals in 25 firms are in software, and 47 individuals in 21 firms in hardware. In terms of the job position in the sample there are 14 Managing Directors, 33 Directors of Research/Development or Chief Technology Officers, 34 senior engineers/developers, 16 mid-level engineers/developers, 6 junior engineers/developers and 2 in other positions. That is, people in senior positions are over-represented in the sample.

Taking a multi-method approach, I arranged face-to-face meetings with the R&D workers and went with them through structured questionnaires and conducted semi-structured interviews.⁶ Overall, the meetings lasted from 20 to 120 minutes (mean

a key ingredient of high-tech agglomerations such as Cambridge (see e.g. Garnsey and Heffernan, 2005; Keeble, 2000; Keeble et al., 1999).

⁶ To reduce biases as much as possible, assurance was given to the interviewees that their accounts would not be divulged to anybody, particularly not to their boss.

45 minutes). The recorded interview material was fully transcribed. Using ATLAS.ti software, the quotes were systematically coded, and those codes were categorized into meta-concepts. The results presented in this paper (in particular Figures 1 and 3) are based on this multi-step coding process.

4. Does the Cambridge IT Cluster really matter?

In this section we investigate to what extent R&D workers benefit from being located in the innovative Cluster.

4.1. Is the Cluster beneficial for R&D workers?

The R&D workers were presented with the following question: “To what extent is it beneficial for your work in your current firm to have many innovative firms/research institutions located in the Cambridge region?”. They could rate it from “1 = very much” to “7 = not at all”. Surprisingly the most frequent answer is “7” (see Table 1), which very strongly indicates that for their work the Cluster is not beneficial at all.

Table 1. “To what extent is it beneficial for your work in your current firm to have many innovative firms/research institutions located in the Cambridge region?” [“1 = very much” to “7 = not at all”] (N=104).

	Total	R&D Managers or Managing Directors	Engineers or developers
1 = very much	13.5%	16.9%	8.9%
2	15.4%	21.7%	12.5%
3	13.5%	13.0%	12.5%
4	8.7%	10.9%	7.1%
5	15.4%	17.4%	14.3%
6	15.4%	2.2%	25.0%
7 = not at all	18.3%	15.2%	19.6%
Mean:	4.1	3.5	4.6 ⁷
Median:	4	3	5

Overall, it seems remarkable that 49.1% explicitly state that it is not beneficial for their work (“5” to “7”) and 8.7% are undecided. Whilst 42.2% think that the Cluster is beneficial (answers “1” to “3”), more than a third of those concern reasons that do not represent knowledge benefits but other advantages which will be discussed in section 6.1. That is, overall, nearly two-thirds of the respondents do not see a *knowledge* benefit for their work.

⁷ The difference of the mean between R&D managers/managing directors and engineers/developers is statistically significant at the 1% level (independent samples t-test).

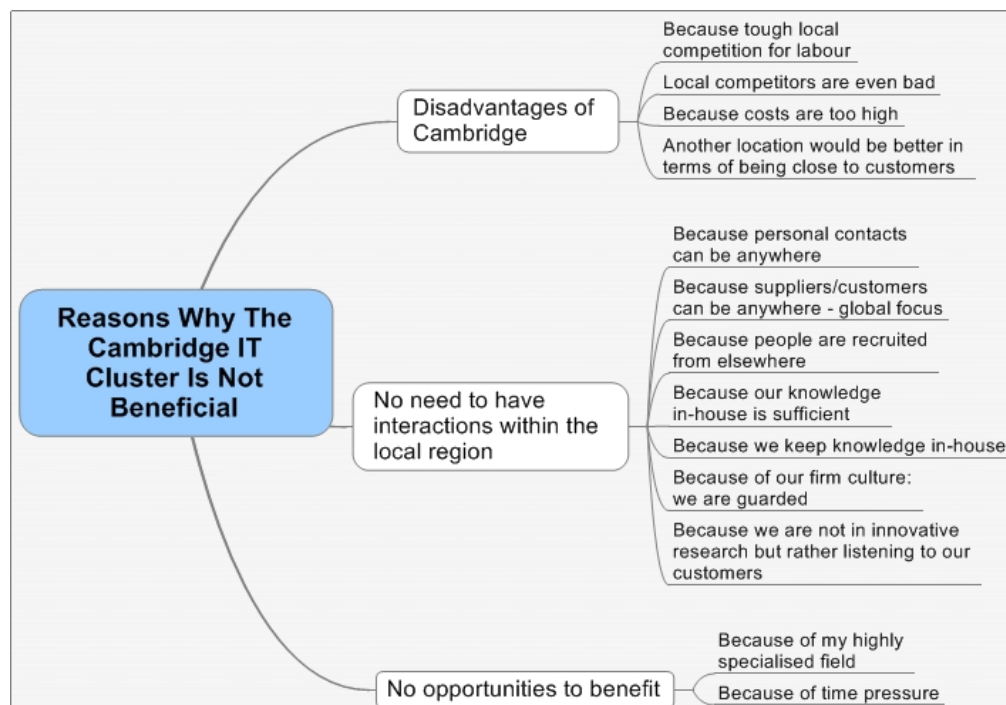
These results suggest that in an innovative technology cluster local knowledge spillovers and territorial learning might not be as widespread as the literature tends to suggest. Instead this supports a more critical view that knowledge networks can be selective (Giuliani, 2007; Morrison and Rabelotti, 2009; Østergaard, 2009), and more fundamentally, even in an innovative technology cluster the sourcing of knowledge from the Cluster environment can be very limited. Furthermore, Table 1 also illustrates that R&D Managers and Managing Directors benefit more from the Cluster (median: '3') than 'pure' engineers or developers (median: '5').⁸

This begs the question of why many believe that they do not benefit. In the following section we will explore this issue.

4.2. Why the Cambridge IT Cluster is not beneficial for R&D workers

The following discussion is based on the analysis of extensive interview material; the respondents had the opportunity to qualify why they think that the Cambridge IT Cluster is not beneficial for their work. Their responses fall into these groups (see Figure 1).⁹

Figure 1. The reasons why R&D workers think that the Cambridge IT Cluster is not beneficial for their work



⁸ Whilst it is beyond the scope of this article to discuss detailed regression analyses, it is important to note that the job position is the most important variable in explaining the variation of the responses. In contrast, the knowledge base of the firm does not make any difference.

⁹ Every single response, even when only mentioned once, was categorized into these types. The frequency of the responses is mentioned approximately in the text. The same applies for Figure 2 below.

The first group of responses highlights *disadvantages* of the Cluster. All of these were stated by people in managerial positions. Several interviewees emphasized that although there is an extensive pool of highly-skilled labor available in the Cluster, local competition between the employers for bright minds is intense, which can be a disadvantage. This was particularly mentioned by small companies, which lack financial stability and kudos. Other reasons mentioned are that the costs (for office space and labor) are too high, and that other locations would be closer to the customers.

Secondly, the most frequently mentioned reason is that there is simply *no need to have interactions* within the local region. The most important arguments mentioned are that personal contacts (see section 5.2 for details) and suppliers and customers can be anywhere because of the global focus of the company. Also, one respondent emphasized that they recruit people from elsewhere and are therefore not dependent on Cambridge. Moreover, several respondents highlighted that their internal knowledge base is sufficient for being successful and nowadays they can access a lot of useful knowledge via the Internet; so there is no need to source knowledge from the local region. Also, a few respondents mentioned that strategically their firm is quite guarded, aims to keep their expertise in-house and does not want to have any knowledge interactions with other Cambridge companies.

Another reason put forward by one firm is that the business model is based on feedback from customers rather than on research; therefore, the research intensive Cambridge environment is not relevant.

A third group of responses underlines that there are *no opportunities to benefit* from the Cluster. The most frequent argument is that the technological field is so highly specific and specialized that there is nobody within the Cluster who could be helpful in terms of either an official business relationship or as a source of knowledge as the following quote illustrates:

“It [the Cambridge Cluster] doesn’t seem to be beneficial in this particular organization. [...] The sort of development work we do is not really the sort of thing that other companies in the area are doing, or has been recently researched by the University.” (Applications Group Manager, small hardware company, spin-off of a Cambridge technology consultancy)

Finally, another reason mentioned a few times is that time pressure both in the work place and in private life severely limits the opportunities for professional socializing and learning from other Cluster companies. Consequently even local

inter-firm mobility often does not result in inter-personal knowledge flows:

“People in this organization have worked in probably every high-tech software company in this region. [...] But I don’t know to what extent people maintain their contacts with previous people. [...] I would suspect that it is probably less than you might believe because you are so busy generally, and work takes up a lot of time. And family life and all as well, and it’s quite difficult to keep that personal thing going.” (Senior Developer, large software company)

This leads us to the next topic.

5. The limited importance of local personal knowledge networks

This section aims to shed light at the widely held belief that firms in clusters benefit from personal knowledge networks. I assess the significance of personal knowledge networks and investigate their spatial dimensions.

5.1. The importance of personal knowledge networks

To examine the overall importance of personal knowledge networks, the interviewees had to assess the following statement: “For people who have a job like mine and want to be successful in it, it is very important to have personal relationships with professional colleagues in other firms or research institutions” (see Table 2).¹⁰

Table 2. “For people who have a job like mine and want to be successful in it, it is very important to have personal relationships with professional colleagues in other firms or research institutions”.

	Frequency	Percent
Strongly agree	18	17.5%
Agree	43	41.7%
Undecided	19	18.4%
Disagree	22	21.4%
Strongly disagree	1	1.0%
Total	103	100.0%

59.2% agree or strongly agree to this statement, the formulation of which seems leading towards the popular view that networks are beneficial. However, several respondents did not explicitly agree: 18.4% are undecided and 21.4% explicitly do not regard contacts to professional colleagues outside of their company as

¹⁰ In this paper a “personal network” refers to the set of individuals and their personal relationships which can be purely private (this is the case for the majority in the sample) or professional (as long as it involves personal acquaintance and goes beyond official duties). A “personal contact” denotes a person with whom somebody has a “personal relationship” with.

important for their current job. Furthermore, several respondents self-critically remarked that personal networks would be important but they do not have any. The most frequent response to the question was that personal networks are very helpful for getting jobs but not necessarily essential for acquiring work-related knowledge.

5.2. Personal knowledge networks not so local after all

Let us now explore the spatial dimensions. Table 3 presents the locations of up to four most important personal contacts outside of the firm for work-related knowledge in the past year. It seems remarkable that 16.5% could not think of a single personal contact, and more than 75.7% could not think of four contacts. For those who have contacts, about two thirds (64.1%) are located outside the Greater Cambridge region.

Table 3. “Location of the personal contacts outside of your firm which were most important as a source of work-related knowledge in the past year”.

	1 st contact	2 nd contact	3 rd contact	4 th contact	All 4 contacts	All 4 contacts
Greater Cambridge Region	29.1%	24.3%	19.4%	7.8%	20.2%	35.9%
Rest of London-Oxford-Cambridge triangle	18.5%	10.7%	4.9%	4.9%	9.7%	64.1%
Rest of UK	16.5%	13.6%	12.6%	6.8%	12.4%	
Rest of Europe	8.7%	6.8%	7.8%	1.9%	6.3%	
USA	9.7%	4.9%	1.9%	1.0%	4.4%	
Rest of the world	1.0%	4.9%	2.9%	1.9%	2.7%	
Do not know	0.0%	1.9%	0.0%	0.00%	0.5%	
Total contacts	83.5%	67.0%	49.5%	24.3%	56.1%	100%
No contact	16.5%	33.0%	50.5%	75.7%	43.9%	
Total	100% (N=103)	100% (N=103)	100% (N=103)	100% (N=103)	100% (N=412)	

This reinforces the survey results in Keeble et al. (1999) that for Cambridge high-technology companies the extra-firm ‘sources of innovating activities’ are strongly non-local. However, our results highlight that also many personal (usually informal) knowledge networks are non-local.¹¹ The results confirm, but are even more pronounced than, the findings by Waters and Lawton Smith (2008) that a significant number of highly skilled scientists and engineers in Oxfordshire and Cambridgeshire have no social networks (generally defined), and non-local networks are more frequent than in-county networks.

The issue of whether the above percentages of non-local personal networks are surprising depends on the theoretical lens. On the one hand, the traditional

¹¹ By “local” I denote the Greater Cambridge Region.

literature would tend to suggest that because of the importance of regular face-to-face interaction, the non-local tendency is rather remarkable. On the other hand, however, one could argue that given that the Cambridge region represents a rather small population, it is not surprising that so many contacts are located somewhere else. Furthermore, the vast majority of the most important personal knowledge networks are still within the UK, and, in particular for the first contacts, a high percentage is within the London-Oxford-Cambridge triangle. This suggests that spatial proximity in a broader sense still matters.

Overall, the empirical results in this section suggest that the role of personal knowledge networks within the Cluster is limited. First, many R&D workers do not regard extra-firm personal networks as important for their work, and many do not have any; that is, the social capital of individuals and the Cluster (Huber, 2009) seems less critical than suggested by the literature. And second, the majority of those personal knowledge contacts that do exist, and can be a conduit for knowledge spillovers, are outside of the Cluster.

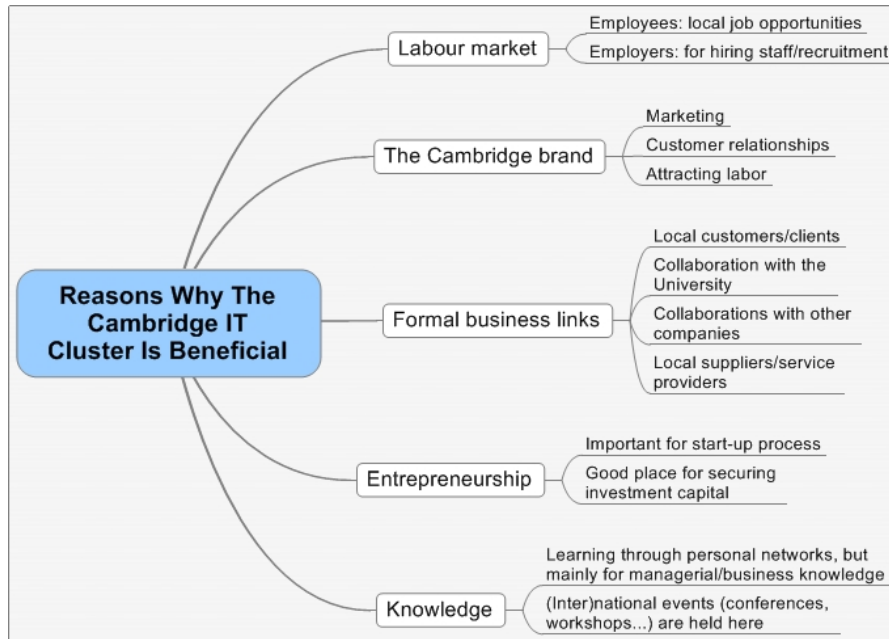
6. Why the Cluster matters

The discussion so far is just one part of the picture. In this section we discuss benefits of the Cluster from the R&D workers' perspective.

6.1. Advantages of the Cambridge IT Cluster

Based on the analysis of the qualitative interviews, Figure 2 provides an overview of the benefits of being located in the Cluster.

Figure 2. Reasons why the Cambridge IT Cluster is beneficial for R&D workers.



6.1.1. Labor market advantages

Importantly, the most frequently mentioned benefit is not directly related the working practices in the current job. Rather, it concerns broader labor market advantages. On the one hand, employees like to work in the Cambridge region for the following reason:

“One of the attractions of Cambridge for me was that if one job didn’t work out, there would be lots of others to choose from. So, that was important for me on a personal level and in terms of career in general.” (Application Group Manager, medium-sized hardware company)

That is, the fact that there are many potential employers in the region is a critical issue for many R&D workers in terms of career perspectives and private dimensions (‘managing’ a family and not having to move house). Interestingly, many of the interviewees believe that this is the only advantage of the Cluster:

“But for my job there is not really any other specific advantage of being in Cambridge.” (Software developer, medium-sized software company)

On the other hand, employers and people involved in recruitment value the Cluster because of the opportunities to attract bright minds, both in terms of recruiting people from other local companies and from elsewhere. Again, many interviewees emphasized that this is the only benefit.

Critically, while personal networks are often not important for sourcing R&D-related knowledge, they can be important for recruitment; subsequently,

technological expertise is not acquired via personal communication but through hiring embodied knowledge:

“I would say Cambridge is pretty beneficial, but not for knowledge contacts. Rather, if we need some skills that we don’t have, we might look to recruit people. And recruiting people within Cambridge is a great way of recruiting. a) there is a large source of people available, and b) because many of us here are from Cambridge. We probably have a quite large local knowledge about who might be available and might be interested. And it’s a great way of finding the right people quickly and readily. So, that sort of networking is very useful at certain times when we are growing teams.” (Senior developer, large software company)

In other words, skilled labor mobility can be an important ‘collective learning’ process (Audretsch and Keilbach, 2005) as has been also shown for Cambridge by Keeble et al. (1999) as well as by Lawton Smith and Waters (2005; 2008). However, although there is some local inter-firm mobility in Cambridge¹², the vast majority of all recruited managers and R&D workers come from outside of Cambridge (Keeble et al., 1999, 326). That is, the flows of embodied expertise operate on multiple spatial scales and collective learning cannot be seen as a local phenomenon. Furthermore, whether inter-firm labor mobility can be regarded as form of knowledge spillover is a contested issue (Breschi and Lissoni, 2001a, 992-4). For instance, if the individuals take certain embodied knowledge with them, knowledge is merely shifted from one place to another and does not lead to a club good or public good. Also, hiring embodied knowledge is not free – as the traditional spillover notion would suggest – but the employers have to pay for it (often a premium for ‘star’ R&D workers).¹³

6.1.2. *The Cambridge brand*

Another frequently mentioned reason why being located in the Cluster is advantageous is of a more subtle nature: individuals and firms benefit from being related to Cambridge as a global ‘brand’ indicating excellence in science and technology:¹⁴

¹² However, the average individual job tenure in Cambridgeshire for scientists and engineers in the study by Lawton Smith and Waters (2005) is 5.78 years; they argue that the rate of turnover is below some of the national metrics and surprisingly slow.

¹³ As the recent study by Maliranta et al. (2009) suggests, labor mobility of R&D workers only increases productivity and profitability when they are hired to non R&D occupations, which was interpreted as indirect evidence that mobility between R&D labs do not seem to be a channel for knowledge spillovers.

¹⁴ The brand of Cambridge is not only constituted by its world-famous university but also by its agglomeration of high-technology companies (with global media coverage such as in the Economist, 2001).

“I’m not sure about other firms or research institutions being beneficial. I think it’s the name Cambridge [...]. If you’re working in Cambridge, people assume that, I don’t know what the word is really, there seems to be a kind of respect because you work in the Cambridge area. I definitely realized this. [...] So it is purely Cambridge as an address.” (Engineer in a small hardware company)

Many R&D workers think that the Cluster does not impact on their current work, but the company enjoys benefits in terms of marketing and getting orders from customers:

“For my own work not at all beneficial. It doesn’t make any difference at all. But I guess we get quite a bit of work because we are in Cambridge, a kudos thing. But not for me personally.” (Developer in a small software company)

For instance, the image of Cambridge makes it easier to attract international customers to visit the company for creating or maintaining business links. Also, it facilitates recruiting R&D workers from abroad.

6.1.3. *Formal business links*

The results confirm that in clusters there are rather limited official transactions going on between firms (Malmberg and Maskell, 2002, 437). Only a rather small subset of companies in the sample benefit from local horizontal or vertical business relations.

First and foremost, several specialist technology companies have local clients/customers. These supply highly specific products for high-tech sectors such as the inkjet or scientific software for research institutions. Here regular face-to-face contacts are often regarded as convenient and useful for effective discussions.

Second, people in only six companies mentioned that collaboration with the University of Cambridge is important for official research collaborations. That is, whilst the University was influential for the emergence of the Cluster (Garnsey and Heffernan, 2005), official collaborations seem to be limited in present days.

Third, a few companies mentioned beneficial collaborations (e.g. sharing of equipment) with other companies, in particular in display technology and in inkjet, where there is a consortium of local firms (Garnsey and Heffernan, 2005, 1136-8).

Fourth, a few interviewees stated that it is convenient, but not critical, to have local suppliers or service providers.

6.1.4. *Entrepreneurship*

Several respondents, usually R&D workers who founded their own company, emphasized that Cambridge is a great place to set up a business because of infrastructure, institutional support and venture capital opportunities as discussed by Garnsey and Heffernan (2005). Interestingly, a few R&D workers highlighted that although Cambridge was important for the start-up phase, it is not important anymore later on, in particular in terms of knowledge flows. This leads us to the next point.

6.1.5. *Knowledge activities*

Only few R&D workers mentioned getting access to knowledge as an advantage of the Cluster. Importantly, nearly all is related to business/management knowledge and not to technological knowledge. That is, access to knowledge through personal networks within the Cluster seems to be more important for entrepreneurs or people in management positions. Within this context, personal contacts can help for hiring embodied knowledge (see the labor market advantages above). Also help and advice on general management issues can be important:

“For instance, the CEO of one of those companies rang me three or four weeks ago, he got the opportunity to quote for a very big job, and his concern was, is this job too big for his company’s size, it could easily suck in all of his resource and kill him, on the other hand. So he was asking my advice off the record. [...] Of course, we actually had that conversation on the phone, so it could have been on the other end of the country, but I think he chose to call me because we had established a personal relationship because it was easy to do so because we see one another, well not regularly, but enough times.” (Product Manager, large hardware company)

In this example co-location enabled regular face-to-face contacts, which enabled trust and led to asking for advice on confidential management issues. Whilst this example confirms the widespread views on the advantages of spatial proximity for knowledge sharing (see 2.1 and 2.2), it hardly applies to *technological* knowledge flows: only two interviewees explicitly mentioned that the Cluster is beneficial to discuss specific technological issues with local personal contacts.

Furthermore, only one person reported that a local ‘networking’ institution – in this case ‘Refresh Cambridge’, a community of web designers and developers – was a source of knowledge. Finally, a couple of people stated that it is convenient that conferences or meetings of national professional societies often happen to be in Cambridge, which is an indirect effect of the Cluster.

6.2. Knowledge spillovers out of sight?

As indicated in section 2.1, some of the literature suggests that regional learning and local knowledge spillovers might happen ‘quasi-automatically’ without any tangible interaction (Bathelt et al., 2004; Malmberg and Maskell, 2002; Staber, 2009). One could argue that the R&D workers might not be aware of such subtle and perhaps ‘tacit’ knowledge flows. Therefore, one might maintain, we cannot trust the responses of the interviewees.

One could argue that the R&D workers might be competent in reflecting on their working practices. Because ‘knowledge work’ is their core activity, reflecting on various sources of knowledge is vital for their professional success. Furthermore, many respondents had lived in other places, including more peripheral regions.¹⁵ Contrastive comparisons of different regions might increase the chances that the workers become consciously aware of place-specific contexts and otherwise ‘hidden’ mechanisms. The following respondent who worked at Silicon Valley before illustrates this:

“Over there [in Silicon Valley] they talk about everything. So you know in detail about other companies. That’s a U.S., Silicon Valley thing. People are just staying in companies a year or two, and you keep your friends. That encourages you to pass information a lot more freely than over here. Here it’s different; people stay in their jobs longer, and there is a bit more loyalty to the company rather than to the social contacts. [...] One of the differences were the sales guys over there you know a lot better. And they know everything that’s going on in other companies. They talk, they go out for dinner, and they tell what’s going on all the time. But it’s not that culture here. They don’t come here, there is less information.” (Principal engineer, medium-sized hardware company)

However, opinions of interviewees generally might not necessarily reflect real-world processes. Certain processes might happen without any noticeable effort while living in Cambridge so that the respondents are not aware of it.¹⁶ More detailed empirical work on mechanisms of potentially ‘hidden’ mechanisms is needed to clarify this issue.

¹⁵ On average the respondents worked for 3.0 (median: 2) firms before their current employment, and they lived at 1.8 (median: 2) places outside of the Greater Cambridge region before.

¹⁶ However, one might question whether really valuable types of knowledge are transferred.

7. Conclusions

While the literature tends to assume that firms located in innovative clusters benefit from access to knowledge networks and technological knowledge spillovers, the results in this paper question this. Nearly two-thirds of the R&D workers in IT companies *do not see a real knowledge benefit* for their work in their current company from being located in one of the most prominent and successful IT clusters in Europe. The most frequent argument why the Cluster is not beneficial is that there is simply no need to interact with other local companies or research institutions. In particular, many R&D workers believe that alternative sources of knowledge such as internal resources or the Internet are sufficient, or preferable, to be successful. This supports studies such as Freel (2003) which suggest that firms' internal resources and competencies are often sufficient for innovation. A further reason why the Cluster is not beneficial is that there are no opportunities to interact and learn. Similar to Moodysson's (2008) results in the life-sciences, this is especially the case for highly specific technological fields. All this confirms and provides a potential explanation of the results by Romijn and Albaladejo (2002), who do not find that regional networks among firms positively affect innovation capability in small electronics and software firms in southeast England (see also Boshuizen et al., 2009). The results suggests that, similar to the insights of Moodysson (2008) for life-sciences, quasi-automatic, non-deliberate local buzz hardly seems to take place.

Furthermore, we explored why the Cluster is of limited importance in terms of *personal knowledge networks*. *First*, we showed that many R&D workers do not believe that extra-firm personal networks are important to do their current job successfully. Furthermore, many R&D workers do not have any, or only very few, extra-firm knowledge networks, which suggests that the significance of extra-firm personal knowledge networks and social capital (Huber, 2009) should not be exaggerated. *Second*, the empirical evidence demonstrates that about two thirds of the most important personal knowledge contacts that do exist are located outside of the Greater Cambridge Region. Although spatial proximity in a broader sense still plays a role since the vast majority of the most important personal knowledge networks are within the UK, the results highlight the potentially globally distributed configuration of personal knowledge networks (e.g. Amin and Cohendet, 2004).

Moreover, the paper also shows *why the Cluster does matter*. For only a few companies local client or supplier relationships, collaborations with the University of Cambridge or other companies are important or convenient. In fact, the most

frequently mentioned advantage of the Cluster is of a more subtle nature: R&D workers like to move and stay in the Cambridge IT Cluster because they believe it offers opportunities of always finding an appropriate job without having to move house. This represents a significant benefit to employers for attracting local and global highly-skilled labor. That is, local labour market pooling and local labour mobility do not only lead to well-known externalities (e.g. Eriksson and Lindgren, 2009) but also to non-local effects: the attraction of global talent.

An additional widely mentioned indirect benefit of the Cluster is the global image or ‘brand’ of Cambridge as a place of excellence in science and technology. This helps companies in terms of marketing, customer relationships and attracting labor. In terms of access to knowledge through personal networks only very few R&D workers see a benefit from the Cluster; this mainly concerns business knowledge of senior managers.

We have addressed the argument that more subtle forms of knowledge flows might take place without the interviewees being aware of them, which deserves further empirical investigation. Overall, the empirical results suggest that the role of knowledge networks and technological spillovers in clusters is overrated.

Finally, I should also emphasize the *limitations* of this study.

First, it is possible that the situation is different for other job roles, for instance, for managers that are not involved in research or development. Indeed, my results suggest that clusters might be more important for sourcing business knowledge than technological knowledge.

Second, the potential sector-specificity of the findings in this paper needs to be highlighted. The networking behavior of engineers/developers in IT might be very distinct. Also, we have to be aware that our study excluded purely service-based companies including technology consultancies which do not offer their own products.

Third, it goes beyond the scope of this paper to investigate the role of knowledge bases and other firm characteristics (but see footnote 8).

Fourth, this study is an in-depth analysis at a specific point in time but does not investigate potential evolutionary processes and why the Cambridge IT Cluster formed historically. The role of agglomeration economies can change throughout the industry life cycle (Neffke et al., 2009).

Fifth, substantial parts of the research are based on opinions of the respondents, which do not necessarily reflect real-world.

Despite these limitations, this study suggests that *innovation policies* should be careful with the assumption that spatial clustering automatically leads to knowledge

spillovers and networks. For many R&D workers, knowledge networks with other Cluster organizations seem irrelevant, since alternative sources of knowledge are regarded as sufficient to be successful. In these cases cluster policies that focus on local networking might be inappropriate (see also Romijn and Albaladejo, 2002). Rather, in this context, policies that support extra-local knowledge linkages or focus on labor market initiatives to attract and retain a critical mass of R&D workers can be more successful.

References

- Amin, A., Cohendet, P. (2004) *Architectures of knowledge: firms, capabilities, and communities*. Oxford: Oxford University Press.
- Asheim, B. T., Coenen, L., Vang, J. (2007) Face-to-face, buzz, and knowledge bases: sociospatial implications for learning, innovation, and innovation policy, *Environment and Planning C: Government and Policy*, 25: 655-70.
- Audretsch, D. B., Feldman, M. P. (1996) R&D spillovers and the geography of innovation and production, *American Economic Review*, 86: 630-40.
- Audretsch, D. B., Feldman, M. P. (2003) Knowledge spillovers and the geography of innovation, in Henderson, J. V., Thisse, J.-F. (eds), *Handbook of Urban and Regional Economics*, Amsterdam: North Holland Publishing.
- Audretsch, D. B., Keilbach, M. (2005) The mobility of economic agents as conduits of knowledge spillovers in Fornahl, D., Zellner, C., Audretsch, D. B. (eds), *The role of labour mobility and informal networks for knowledge transfer*, pp. 8-25. New York: Springer.
- Bathelt, H. (2005a) Cluster relations in the media industry: exploring the 'distanced neighbour' paradox in Leipzig, *Regional Studies*, 39: 105-27.
- Bathelt, H. (2005b) Geographies of production: growth regimes in spatial perspective 2 - knowledge creation and growth in clusters, *Progress in Human Geography*, 29: 204-16.

- 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: 31-56.
- Benner, C. (2003) Learning communities in a learning region: the soft infrastructure of cross-firm learning networks in Silicon Valley, *Environment and Planning A*, 35: 1809-30.
- Boggs, J. S., Rantisi, N. M. (2003) The 'relational turn' in economic geography, *Journal of Economic Geography*, 3: 109-16.
- Boschma, R. A., Ter Wal, L. J. (2007) Knowledge networks and innovative performance in an industrial district: the case of a footwear district in the south of Italy *Industry and Innovation*, 14: 177-99
- Boshuizen, J., Geurts, P., Van der Veen, A. (2009) Regional social networks as conduits for knowledge spillovers: explaining performance of high-tech firms, *Tijdschrift Voor Economische En Sociale Geografie*, 100: 183-97.
- Breschi, S., Lissoni, F. (2001a) Knowledge spillovers and local innovation systems: a critical survey, *Industrial and Corporate Change*, 10: 975-1005.
- Breschi, S., Lissoni, F. (2001b) Localised knowledge spillovers vs. innovative milieu: knowledge "tacitness" reconsidered, *Papers in Regional Science*, 80: 255-73.
- Breschi, S., Malerba, F. (2001) The geography of innovation and economic clustering, *Industrial and Corporate Change*, 10: 817-33.
- Bunnell, T. G., Coe, N. M. (2001) Spaces and scales of innovation, *Progress in Human Geography*, 25: 569-89.
- Camagni, R. (1991) Introduction: from the local 'milieu' to innovation through cooperation networks, in Camagni, R. (ed.), *Innovation Networks: Spatial Perspectives*, London: Belhaven-Pinter.
- Caniels, M. C. J., Romijn, H. A. (2005) What drives innovativeness in industrial clusters? Transcending the debate, *Cambridge Journal of Economics*, 29: 497-

- Capello, R., Faggian, A. (2005) Collective learning and relational capital in local innovation processes, *Regional Studies*, 39: 75-87.
- Carter, A. P. (1989) Know-how trading as economic exchange, *Research Policy*, 18: 155-63.
- Dahl, M. S., Pedersen, C. O. R. (2004) Knowledge flows through informal contacts in industrial clusters: myth or reality?, *Research Policy*, 33: 1673-86.
- Dahl, M. S., Pedersen, C. O. R. (2005) Social networks in the R&D process: the case of the wireless communication industry around Aalborg, Denmark, *Journal of Engineering and Technology Management*, 22: 75-92.
- Döring, T., Schnellenbach, J. (2006) What do we know about geographical knowledge spillovers and regional growth? A survey of the literature, *Regional Studies*, 40: 375-95.
- The Economist* (2001) Cambridge's high-tech cluster, 12th April 2001.
- Eriksson, R., Lindgren, U. (2009) Localized mobility clusters: impacts of labour market externalities on firm performance, *Journal of Economic Geography*, 9: 33-53.
- Feldman, M. P. (1999) The new economics of innovation, spillovers and agglomeration: a review of empirical studies, *Economics of Innovation and New Technology*, 8: 5-25.
- Freel, M. S. (2003) Sectoral patterns of small firm innovation, networking and proximity, *Research Policy*, 32: 751-70.
- Garnsey, E., Heffernan, P. (2005) High-technology clustering through spin-out and attraction: the Cambridge case, *Regional Studies*, 39: 1127-44.
- Gertler, M. S. (2003) Tacit knowledge and the economic geography of context, or the undefinable tacitness of being (there), *Journal of Economic Geography*, 3: 75-99.
- Giuliani, E. (2005) Cluster absorptive capacity - Why do some clusters forge ahead

- and others lag behind?, *European Urban and Regional Studies*, 12: 269-88.
- Giuliani, E. (2007) The selective nature of knowledge networks in clusters: evidence from the wine industry, *Journal of Economic Geography*, 7: 139-68.
- Giuliani, E., Bell, M. (2005) The micro-determinants of meso-level learning and innovation: evidence from a Chilean wine cluster, *Research Policy*, 34: 47-68.
- Grabher, G. (2002) The project ecology of advertising: Tasks, talents and teams, *Regional Studies*, 36: 245-62.
- Grabher, G. (2006) Trading routes, bypasses, and risky intersections: mapping the travels of 'networks' between economic sociology and economic geography, *Progress in Human Geography*, 30: 163-89.
- Grabher, G., Ibert, O. (2006) Bad company? The ambiguity of personal knowledge networks, *Journal of Economic Geography*, 6: 251-71.
- Grabher, G., Powell, W. W. (2005) Introduction, in Grabher, G., Powell, W. W. (eds), *Networks*, pp. xi-xxxii. Cheltenham: Edward Elgar.
- Henderson, J. V. (2007) Understanding knowledge spillovers, *Regional Science and Urban Economics*, 37: 497-508.
- Henry, N., Pinch, S. (2000) Spatialising knowledge: placing the knowledge community of Motor Sport Valley, *Geoforum*, 31: 191-208.
- Huber, F. (2009) Social capital of economic clusters: towards a network-based conception of social resources, *Tijdschrift Voor Economische En Sociale Geografie*, 100: 160-70.
- Ibrahim, S. E., Fallah, M. H., Reilly, R. R. (2009) Localized sources of knowledge and the effect of knowledge spillovers: an empirical study of inventors in the telecommunications industry, *Journal of Economic Geography*, 9: 405-31.
- Jaffe, A. B., Trajtenberg, M., Henderson, R. (1993) Geographic localization of knowledge spillovers as evidenced by patent citations, *Quarterly Journal of Economics*, 108: 577-98.
- Keeble, D. (2000) Collective learning processes in European high-technology

- milieux, in Keeble, D., Wilkinson, F. (eds), *High-Technology Clusters, Networking and Collective Learning in Europe*, pp. 199-229. Aldershot: Ashgate.
- Keeble, D., Lawson, C., Moore, B., Wilkinson, F. (1999) Collective learning processes, networking and 'institutional thickness' in the Cambridge region, *Regional Studies*, 33: 319-32.
- Keeble, D., Lawson, C., Smith, H. L., Moore, B., Wilkinson, F. (1998) Internationalisation processes, networking and local embeddedness in technology-intensive small firms, *Small Business Economics*, 11: 327-42.
- Kesidou, E., Caniels, M. C. J., Romijn, H. A. (2009) Local knowledge spillovers and development: an exploration of the software cluster in Uruguay, *Industry and Innovation*, 16: 247-72.
- Lawson, C., Lorenz, E. (1999) Collective learning, tacit knowledge and regional innovative capacity, *Regional Studies*, 33: 305-17.
- Lawton Smith, H., Waters, R. (2005) Employment mobility in high-technology agglomerations: the cases of Oxfordshire and Cambridgeshire, *Area*, 37: 189-98.
- LibraryHouse (2004) *Flight to quality. The Cambridge cluster report 2004*, The Library House, Cambridge.
- Lissoni, F. (2001) Knowledge codification and the geography of innovation: the case of Brescia mechanical cluster, *Research Policy*, 30: 1479-500.
- MacKinnon, D., Cumbers, A., Chapman, K. (2002) Learning, innovation and regional development: a critical appraisal of recent debates, *Progress in Human Geography*, 26: 293-311.
- Maliranta, M., Mohnen, P., Rouvinen, P. (2009) Is inter-firm labor mobility a channel of knowledge spillovers? Evidence from a linked employer–employee panel, *Industrial and Corporate Change*, doi:10.1093/icc/dtp031
- Malmberg, A., Maskell, P. (2002) The elusive concept of localization economies: towards a knowledge-based theory of spatial clustering, *Environment and Planning A*, 34: 429-49.

- Malmberg, A., Power, D. (2005) (How) do (firms in) clusters create knowledge?, *Industry and Innovation*, 12: 409-31.
- Martin, R., Sunley, P. (2003) Deconstructing clusters: chaotic concept or policy panacea?, *Journal of Economic Geography*, 3: 5-35.
- Maskell, P., Malmberg, A. (1999) Localised learning and industrial competitiveness, *Cambridge Journal of Economics*, 23: 167-85.
- Moodysson, J. (2008) Principles and practices of knowledge creation: on the organization of "buzz" and "pipelines" in life science communities, *Economic Geography*, 84: 449-69.
- Morrison, A., Rabellotti, R. (2009) Knowledge and information networks in an Italian wine cluster, *European Planning Studies*, 17: 983-1006.
- Moulaert, F., Sekia, F. (2003) Territorial innovation models: a critical survey, *Regional Studies*, 37: 289-302.
- Neffke, F., Svensson Henning, M., Boschma, R. A., Lundquist, K.-J., Olander, L.-O. (2009) The dynamics of agglomeration externalities along the life cycle of industries, *Regional Studies*, forthcoming.
- Oinas, P. (1999) Activity-specificity in organizational learning: implications for analysing the role of proximity, *GeoJournal*, 49: 363-72.
- Østergaard, C. R. (2009) Knowledge flows through social networks in a cluster: comparing university and industry links, *Structural Change and Economic Dynamics*, 20: 196-210.
- Østergaard, C. R. (forthcoming) Knowledge flows through social networks in a cluster: interfirm versus university-industry contacts, *Structural Change and Economic Dynamics*.
- Pittaway, L., Robertson, M., Munir, K., Denyer, D., Neely, A. (2004) Networking and innovation: a systematic review of the evidence, *International Journal of Management Reviews*, 5-6: 137-68.
- Porter, M. E. (1998) *On competition*. Boston, MA: Harvard Business School Press.

- Romijn, H., Albaladejo, M. (2002) Determinants of innovation capability in small electronics and software firms in southeast England, *Research Policy*, 31: 1053-67.
- Sattler, H., Schrader, S., Lüthje, C. (2003) Informal cooperation in the US and Germany: cooperative managerial capitalism vs. competitive managerial capitalism in interfirm information trading, *International Business Review*, 12: 273-95.
- Saxenian, A. (1989) The Cheshire cats grin - innovation, regional-development and the Cambridge case, *Economy and Society*, 18: 448-77.
- Saxenian, A. (2006) *The new argonauts. Regional advantage in a global economy*. Cambridge, MA (USA): Harvard University Press.
- Saxenian, A. L. (1996) *Regional advantage: culture and competition in Silicon Valley and Route 128*. Cambridge, MA: Harvard University Press.
- Schrader, S. (1991) Informal technology-transfer between firms - cooperation through information trading, *Research Policy*, 20: 153-70.
- Simmie, J., Carpenter, J., Chadwick, A., Martin, R., Wood, P. (2006) *State of the English cities. The competitive economic performance of English cities*. London: Department for Communities and Local Government.
- Staber, U. (2009) Collective learning in clusters: mechanisms and biases, *Entrepreneurship & Regional Development*, 21: 553-73.
- Storper, M. (1997) *The regional world: territorial development in a global economy*. London: Guilford Press.
- Storper, M. (2007) Book review: Saxenian: The new argonauts. Regional advantage in a global economy, *Journal of Economic Geography*, 7: 113-7.
- Storper, M., Venables, A. J. (2004) Buzz: face-to-face contact and the urban economy, *Journal of Economic Geography*, 4: 351-70.
- Von Hippel, E. (1987) Cooperation between rivals: informal know-how trading, *Research Policy*, 16: 291-302.

- Waters, R., Lawton Smith, H. (2008) Social networks in high-technology local economies - The cases of Oxfordshire and Cambridgeshire, *European Urban and Regional Studies*, 15: 21-37.
- Yeung, H. W. C. (2005) The firm as social networks: An organisational perspective, *Growth and Change*, 36: 307-28.
- Zucker, L. G., Darby, M. R., Armstrong, J. (1998) Geographically localized knowledge: Spillovers or markets?, *Economic Inquiry*, 36: 65-86.