To what extent do different sectors 'socialize' innovation differently? Cooperation in knowledge intensive industries in the Ottawa region[1]

David Doloreux
School of Management, University of Ottawa (Canada)
Doloreux@management.uottawa.ca

Henrik Mattsson
School of Management, University of Ottawa (Canada) &
Dept. of Social and Economic Geography and CIND,
Uppsala University (Sweden) henrik.mattsson@kultgeog.uu.se

FIRST DRAFT 30-04-20007 - no language wash

ABSTRACT: Most of the research on collaborative relationships in innovation looks at the role of regional knowledge sources and innovation partners, as well as the benefits of collaborating within industrial clusters and regional innovation systems. Relatively few studies have provided convincing empirical evidence of the relative importance and/or superiority of local over non-local forms of cooperation in innovation. The objective of this paper is to produce new empirical evidence pertaining to the nature and geography of cooperation in different knowledge intensive sectors in the Ottawa region. Based on a recently completed survey of 172 firms in the Ottawa region, explanations for different collaborative patterns between high and medium tech manufacturing firms and knowledge intensive business services are drawn out.

KEY-WORDS Manufacturing firms, KIBS, innovation, cooperation, Ottawa region

1. Introduction

During the last decade, there have been a growing number of theoretical and empirical studies about the roles of cooperation and innovation networks (e.g. Freel and Harrison, 2006; Tödtling et al., 2006; Dahlander and McKelvey, 2005; Oerlemans and Meeus, 2005; Pittaway et al., 2004; Diez, 2000). By and large, these studies, among others, have

[1] This research was made possible by financial support of Social Sciences and Humanities Research Council within the program 'Major Research Initiatives (MCRI)'. We have benefited from valuables comments from Caroline Andrew and Tyler Chamberlin and the coordinators of the project, David Wolfe and Meric Gertler. The usual disclaimers apply.

shown that cooperative relations have positively enhanced a firm's development and diffusion as well as its performance and growth.

This research has also contributed to the debate over the role of spatial proximity of cooperative agents affecting innovation (e.g. Crevoisier, 2005; Doloreux, 2004a; Freel, 2003; Kotschatzky et al., 2001; Sternberg, 2001; Maskell and Malmberg, 1999). These studies have shown that the capacity for sustained innovation is rooted in a complex set of relationships between internal firm dynamics and the external environment in which the firms are embedded (see also Dicken and Malmberg 2001). It is now recognized that that this capacity is sustained through regional communities of firms and supporting networks of institutions sharing both a common knowledge base and the benefits of access to specialized resources, skills, and competencies (Asheim and Coenen, 2005; Hoolbrook and Wolfe, 2005).

The territorial innovation models' literature (Moulaert and Sekia, 2003) acknowledges to varying degrees that firms' innovation is embedded within collaborative networks and in their regional economy. For instance, the regional innovation system literature highlights the importance of socio-cultural structures and institutional environments to stimulate cooperation in the interest of innovation (Cooke, 2007; Asheim and Gertler, 2005; Doloreux and Parto, 2005). The industrial district literature emphasizes the importance of trust-based interaction in the establishment of cooperation among firms (Belussi, 2005; Becattini, 2004). In a similar way, the learning region and innovative milieu literature insists on the role of social and cultural factors in enabling cooperation between the different agents in the region (Crevoisier, 2004). The cluster literature emphasizes that co-located firms increase intra-industry knowledge flow with suppliers, customers, rivals, and supporting institutions (Wolfe and Gertler, 2004; Porter, 1998; Saxenian, 1994).

Most of the research on collaborative relationships in innovation looks at the role of regional knowledge sources and innovation partners, as well as the benefits of collaborating within industrial clusters and regional innovation systems. Relatively few studies have provided convincing empirical evidence of the relative importance and/or superiority of local over non-local forms of cooperation in innovation. For instance, in opposition and contrast to this kind of regional focus, it has been argued forcefully that 'there is a need for a qualitative shift away from work which focuses on particular scales as the locus for understanding innovation, towards that which gives more credence to relationships operating between and across different scales' (Bunnel and Coe, 2001: 570). This observation is also supported by Tödtling et al. (2006: 1037) who stress that 'what is often missing is a clear differentiation of these relations, both conceptually and empirically. There is no clarity as regards the type of relations as well as their geography'. Yet, what remains to be explored is the nature and relative significance of proximate versus distant collaboration in innovative activity (Oinas and Malecki, 2002) in order to find out how innovative firms are connected to regional, national and international innovation systems.

The objective of this paper is to produce new empirical evidence pertaining to the nature of cooperation in different knowledge intensive sectors in the Ottawa region, and most

importantly to analyze the relative importance of localized versus distant forms of cooperation. The current research addresses the following four questions:

(1) What are the characteristics of cooperative firms compared to non-cooperative firms?
(2) How important is cooperation and which are the relevant partners?
(3) What geographical patterns are characteristics for innovative cooperation and which types of firms are more integrated into regional, national and international innovation systems?
(4) What significant differences exist with regard to cooperation patterns between high-tech manufacturing firms and service-oriented knowledge intensive businesses?

2. Cooperation and the geographical scale of cooperation: the point of departure and the new debate

There have been many twists and turns in the debate over the occurrence and spatial distribution of cooperation in recent years. In the current literature, various hypotheses have been developed to account for the social nature of innovation, and the importance of cooperation amongst various agents in that process.

The wide-ranging literature on innovation and regional science studies has tended to pursue two lines of enquiry. The interactions between agents and their local environment in the innovation process are analysed in an initial set of research. One principal concern in these studies is the proximity between actors and their local and regional environments are increasingly seen as important determinants of knowledge dissemination. Here, the role of local and regional environment and proximity are not merely related to the benefits created by the concentration of economic activities in terms of access to markets, to suppliers, to a varied and qualified workforce, to formal and informal networks, to specialised service industries, and to a high quality technological infrastructure (Maskell and Kébir, 2006; Storper, Malmberg and Maskell, 2001; Storper, 1997). More importantly, in terms of its geographical implications, tacit knowledge also depends upon social interactions for its transfer and dissemination (Gertler, 2003). The essential argument is that the effective transmission of uncodified or tacit knowledge depends on spatial proximity. Owing to the unique set of conditions required to generate and communicate such knowledge – including, of course, the institutional framework which shelters these highly interactive processes – tacit knowledge is strongly context-bound and in this sense, sticky (von Hippel, 1988).

In addition, work on these issues also tends to emphasize the role played by clusters and regional innovation systems in facilitating and promoting processes of cooperation and innovation (Cooke et al., 2004; Doloreux, 2002). In part, this is because innovation is fundamentally a geographical process and that innovation capabilities are sustained through regional communities that share common knowledge and institutional bases (Asheim and Isaksen, 2002). Here, a key factor of explanation is the shared trust that is assumed to operate in the context of a locally defined set of habits and conventions. Trust

and the local culture have been closely linked to the milieu (or the institutional set-up), or at least have both been important reference points for analyses aimed at understanding learning and knowledge processes (Maskell and Malmberg, 1999). It is assumed that the milieu generates the prevalent social and cultural conditions of communication, language, and collective learning, including distinctive ways of developing, storing, and disseminating knowledge.

More recently, a second series of research has focused on the role of extra-regional networks and institutions as mechanisms of knowledge generation and circulation, and their contribution to innovation. Empirical evidence is gradually put forward pointing to the fact that firms in clusters receive much information and knowledge from extra-regional actors (Amin and Thrift 2002). The main emphasis on local interaction and knowledge circulation is questioned, and knowledge flows, inter-regional and international relationships are seen as crucial forms of innovation dynamics (Gertler and Wolfe 2006). On this issue, the research has been developed to account for the relative importance of non-local forms of interactive learning. Several authors have stressed that local and global flows of knowledge may in fact be complementary in the process of innovation (Asheim and Gertler, 2005; Wolfe and Gertler, 2004; Simmie, 2004). It is also the case that a cluster or a regional innovation system is *open* in the sense that information, ideas and knowledge to be employed by firms in their innovation process can come from actors and sources both within and outside of the cluster or region in question (Doloreux, 2004; Gertler and Levitte, 2005).

From a conceptual point of view, Bathelt et al. (2004) proposed the 'local-buzz – global pipelines' metaphor to explain the advantage conferred by the co-existence of both a high-level of local embeddedness and well developed networks with global partners to successful innovative firms and clusters. While local networks permit frequent use of information and communication developed through both face-to-face contact (Storper and Venables 2004), and shared values and social norms within a particular cluster; global networks are instead associated with the integration of multiple selection environments that open different potentialities in the innovation process.

From a empirically point of view, several studies have now analyzed how firms make use of endogenously generated and exogenously available knowledge to strengthen competencies and maintain competitiveness in the process of innovation. Studies supporting the significance of proximate and distant connections in innovative activity include Grotz and Braun's (1997) work on the German mechanical engineering industry, Suarlez-Villa and Walrod's (1997) study in the California electronic industries, Hendry's et al., (2000) analysis on opto-electronics industries in Europe, Kalafsky and MacPherson's (2002) study on U.S. machine tool companies, Wood et al. (2004) studies of Sheffield metalworking firms, Nachum and Keeble's (2003) investigation on media firms in central London and Britton's (2007) analysis on media industry in Toronto, and Dahlander and Mckelvey (2005) and Tödtling et Trippl (2007) and Mattsson (2007) studies on biotech firms in Gothenburg, Vienna and Sweden. These studies have shown that although innovative firms are strongly embedded in a local cluster, they also maintain cooperation that extends well beyond the local cluster or regional innovation

system, and therefore innovative cooperation take place at regional, national and international levels.

In the context of this paper, we present the empirical results from our study on cooperation patterns in different knowledge intensive industries in the Ottawa region. Among the few studies that deal with innovative cooperation in the Ottawa region, Madill et al. (2004), for example, demonstrate that non-technology firms value more regional linkages than technology-based firms within the Ottawa cluster. The study consequently assumes that technology-based firms value more linkages and relations with similar firms outside the cluster and the region, even when located in a dynamic regional cluster. Doloreux's (2004a) study shares similar results. Based a sample of 52 high-tech firms in Ottawa, his study reveals that high-tech firms rely as much on external networks of customers and suppliers as they do on those based in their own region, and these external connections are considerably more important than other potential sources of new ideas to the innovation process within the firms. In this research, we address specifically the respective contribution of local, national and international cooperation in supplying firms with ideas, information, and knowledge. The principal aim is to investigate to what extent various sectors 'socialize' innovation differently in the Ottawa region.

3. Empirical evidence from the region of Ottawa

3.1 Background to Ottawa's innovation system

Labeled 'Silicon Valley North' due to a swift rise of its technological-oriented development (Shavinina, 2004), the region of Ottawa has become a world-class technology center, which is dominated by Canada's leading technology cluster in ICT, semiconductor, and software, and of growing poles for optoelectronic and life science industries (Chamberlin and de la Mothe, 2003). Furthermore, the region contains many of the location conditions recognized as attractive to investors and workers in high-tech industries, including an educated workforce, two well-respected universities (University of Ottawa and Carleton University), nine research institutes of the National Research Council and the Communication Research Center; 12 venture capital organizations and 19 venture capitalists who are active investors in the region; the Ottawa Centre for Research and Innovation; and several supporting organizations dedicated to entrepreneurship and technological development (Doloreux, 2004a).

Ottawa is the capital-region of Canada and is situated in the Province of Ontario's South-East. In 2005, the total population numbered over one million inhabitants, making it the fourth largest region in Canada, after Toronto, Vancouver and Montreal. At the end of 2005, Ottawa accounted for over 29,000 enterprises and 631,000 workers. Currently regional employment is largely concentrated in business services (23.5 per cent), public administration (18.6 per cent) and educational and health services (16.0 per cent). The unemployment rate in Ottawa is far below the national average (5.6 per cent compared to 7.4 per cent). The region includes high proportions of research-intensive occupations with 25.9 per cent of workforce having a BA degree or higher (compared to 15.4 per cent for the national average).

During the 1990s, Ottawa cemented its reputation as a high-tech city. At the end of 2005, Ottawa accounted for over 1,500 technology companies and 67,000 workers; numbers which have been continuously increasing since the 1990s. The industrial structure of Ottawa shows clear territorial clustering of firms. The software industry concentrated 20 per cent of companies in one area, making it the largest cluster in Ottawa, followed by telecommunications (15.0 per cent of high tech workers), microelectronics and photonic clusters (both with 7.0 per cent). The high tech sectors are dominated by small firms, with 84.0 per cent of companies employing fewer than 50 employees in 2004, and about 50 firms in Ottawa employing more than 500 employees, with such major employers as Nortel, Bell Canada, Convergys, Calian Technologym, and Alcatel.

Ottawa also accounts for the largest part of Canada's R&D and patent activity. Ottawa is the leading Canadian region for R&D expenditure, accounting for more than 20 per cent of the total Canadian expenditure in R&D. Furthermore, in 2005, Ottawa is the Canadian region with the highest number of patent applications.

3.2 Database and survey

The empirical findings presented here were collected in the context of the ISRN-City-Region initiative project 'Social Dynamics of Economic Performance: Innovation and Creativity in City-Regions'. The ISRN-City-Region initiative project is a five year-study focusing on the social determinants of urban economic performance and is particularly interested in exploring the extent to which social characteristics and processes in city-regions determine their economic vitality and dynamism as centers of innovation and creativity. Three specific dimensions of social dynamics and their relationship to the economic dynamism of city-regions are explored in this project: the social nature of the innovation process, the social foundations of talent attraction and retention, and the degree of community inclusiveness and civic engagement. The project examines 15 case study city-regions in Canada, both large and small metropolitan areas are included.

A survey firm who conducted computer-assisted telephone interviews from November 27, 2006 to February 27, 2007, collected the data used in this study. The purpose of the survey was to collect information on the innovation and cooperation behaviors of manufacturing firms and service businesses. The questionnaire covered the following issues:

- General information about the firm: firms were asked questions about their characteristics such as age, legal status, size (employment and turnover), share of exports, main activities, etc.

- Innovation activities: adapted from the third edition of the Oslo Manual, firms were asked questions about their innovation activities for innovation inputs (R&D, external R&D, acquisition of machinery and equipment, acquisition of external competences, and employee training) as well as innovation outputs (new or significantly improved product and process innovation in the past three years). Additional questions asked about strategies and obstacles related to innovation activities.

- Innovation cooperation: firms were asked questions about the external source of knowledge they used for their innovation activities, the type of collaborators and their geographical location, and the types and mechanisms of knowledge exchange.

The Canadian Company Directory[2] developed by Industry Canada provided the list of firms used to conduct the survey. The initial list included a sample of 394 firms. Out of this sample list, 12 respondents were neither manufacturing nor KIBS firms, 130 respondents refused to participate in the survey, 61 respondents were impossible to reach after 50 calls, 9 questionnaires were not completed, and 172 questionnaires were completed and usable. This means a return rate of 43.6 per cent (Table 1). It is important to specify that the research does not intend to be representative of manufacturing and KIBS firms in Ottawa, but rather concentrate on industries connected to the leading 'clusters' in Ottawa. Therefore, this response rate is higher than or similar to most regional surveys administrated to manufacturing and KIBS firms, and therefore provided a reasonable baseline to compare the results between industries in an individual region (see for instance Tödtling and Trippl, 2006; Freel and Harrison, 2006; Cumbers et al., 2003; Diez, 2002).

Two broad comparisons were drawn between patterns of cooperation; the sectors were classified according to OECD classification (OECD, 2001) and grouped in two sectors:

(1) High and Medium Tech Manufacturing (HMTM): here are included all manufacturing firms that are defined as High-technology by OECD classification (OECD, 2001), and include Chemical Manufacturing (NAICS 325), Machinery Manufacturing (NAICS 326), Computer and Electronic Product (NAICS 334), Electronic Equipment and Component (NAICS 335), and Transportation Equipment (NAICS 336);

(2) Knowledge Intensive Business Service (KIBS): here are included all service businesses that are defined as KIBS by (Muller and Doloreux, 2007), and include professional, scientific and technical services (NAICS 541), Internet Publishing (NAICS 516) and Telecommunication (NAICS 517).

Table 1. Sample for firm survey in Ottawa

Target group (NAICS)	Sample	Return	Response rate (%)
High and Medium Tech Manufacturing	116	66	56.8
Knowledge Intensive Business Service	278	106	38.1
Total	*394*	*172*	*43.6*

Source: Ottawa ISRN firm survey, 2007

[2] http://strategis.ic.gc.ca/sc_coinf/engdoc/homepage.html

3.3 Descriptive statistics of the surveyed firms

This section discusses general characteristics of the Ottawa firms, as well as for the two sub-groups of firms. The descriptive statistics of the surveyed firms are presented in Table 2.

The sample taken as a whole consists of 172 firms. The firms are rather young with a mean age of 16.3 years. The oldest firm was established in 1920, whereas the most recent was founded in 2005. In terms of size, the vast majority of firms are small. On average, the surveyed firms employed 42 people. The largest firm employs 500 people and the smallest firms have 1 employee. The average turnover is approximately 13.6 millions dollars, but this pattern is extremely diverse, ranging from 56,000 to 600 millions dollars. In terms of exports, more than 54.1% firms declared having sold their products and services on markets outside of Canada. The average sales by firms on foreign markets are also extremely skewed. On average, they account for 22.1% of sales, but with a large variance: 45.9% of firms do not export their products and services; 47.8% of firms' exports more than 80% of their revenues outside Canada; and, 15.2% of firms declare that their revenues are distributed only on international markets.

When comparing the two cohorts of firms, we can see that, internally, they are both quite heterogeneous. However, as is evident in Table 2 the two cohorts are fairly similar in terms of general characteristics, with some exceptions. KIBS are smaller (35.2 employees on average) and have a lower turnover (5.5 million dollars) than the HMTM, but the former group has a larger number of employees with a university degree. Firms within HMTM more actively export than KIBS but a majority of the firms in the two cohorts have no exports at all. This is especially interesting to note when considering how close Ottawa is to the US border. HMTM as a group have higher annual turnover than KIBS, but the numbers are similar if the five largest HMTMs are excluded.

Table 2. Descriptive statistics of all firms in the survey

	All firms (n=172)					HMTM (n=66)					KIBS (n=106)				
	Mean	Med.	Std	Min	Max	Mean	Med.	Std	Min	Max	Mean	Med.	Std	Min	Max
Age (years)	16.3	14.0	11.89	2	87	16.8	13.5	12.17	2	68	16.1	14.0	11.76	3	87
Employees	41.7	20.0	73.46	1	500	52.0	21.5	94.15	1	500	35.2	20.0	56.50	1	450
Employees with university degree	17.7	7.5	38.69	0	300	23.5	5.0	57.63	0	300	13.9	10.0	17.1	0	95
Sales[4] (000,000)	13.7	1.6	70.7	56k	600	28.1	2.2	114.6	0.2	600	5.5	1.5	15.2	56K	100
Exports[5]	22.1	0.00	35.78	0	100	35.2	0.0	41.88	0	100	15.4	0	30.12	0	100

[1] Firm age in years; [2] Employees for 2005;[3] Employees with Bachelor degree of higher for 2005;[4] Sales for 2005;
[5] Share of sales on foreign international markets in 2005

Source: Ottawa ISRN firm survey, 2007

4. Empirical evidence

This section serves to discuss (i) differences between cooperating and non-cooperating firms; and, (ii) geographical patterns of cooperation and knowledge sourcing. Information about firm characteristics was gathered through a number of questions. One group of questions is about the basic characteristics of the surveyed firms, such as: firm's age in years, employees, employees with a university degree, turnover, and exports. Another group of questions tries to understand how firms interact and a third group of questions gather information on the main innovation and R&D activities of the studied firms.

4.1 The characteristics of cooperating firms (and non cooperating firms)

The following discussion related to the characteristics of cooperating firms and non cooperating firms in Ottawa. Table 3 contains the results of several *T-tests* for the independent samples. In general, the results reveal some differences between cooperative and non-cooperative firms. For HMTM, however, cooperating and non-cooperating firms are rather similar in their general characteristics and in their innovative behavior, while KIBS show more noticeable differences between cooperating and non-cooperating firms. The differences between the two cohorts are detailed below.

Firstly, there are no significant differences between co-operative and non-cooperating firms with regard to relevant firms attributes such as, for instance, age, size, employees with a university degree, sales and exports, and this is true for both cohorts of firms. It turns out that cooperating KIBS have larger annual turnovers than their non-cooperating counterparts. Cooperating HMTM are larger and export more than non-cooperating firms within the same cohort but these differences are not statistically significant.

Secondly, there exist remarkable differences between cooperative firms and non-cooperative firms with respect to innovation activities, differences that are even more obvious between cooperative and non-cooperative KIBS. Notably, the results show that the share of cooperative firms tends to be higher than non-cooperative firms and this is consistent for both HMTM and KIBS, and across different types of innovation activities. This indicates that cooperativeness may influence greatly the propensity of firms to carry out innovation activities. Conversely, intersectoral differences in the frequency of cooperating firms with innovation activities are less pronounced than between cooperating and non-cooperating firms if the individual cohorts are compared together.

Third, co-operating firms are more successful in creating innovations and introducing new or significantly new goods, services and processes than those firms who do not maintain external cooperation during the innovation process. There are significant statistical relations between innovation types and the cooperative and non-cooperative firms. Both cohorts are characterized by remarkably high levels of product-, service- and process-innovation. However, there are differences between the two cohorts. HMTM introduce 'new or slightly improved products' and 'new or slightly improved processes' more frequently, whereas KIBS, not surprisingly, have introduced more 'new or slightly improved services'. This result partly supports a notion developed in other research, namely that innovation in KIBS is distinctive from HMTM innovation (Tödtling et al., 2006; Camacho and Rodriguez, 2005). It also shows that manufacturing firms, in general,

pursue competitive strategies via the introduction of product innovation, and the importance of the interrelated nature of product and process innovation. Frequently, process innovation is an integrated part of product innovation. This would happen when, for instance, a new product could not be manufactured with the conventional production methods.

Table 3. Characteristics of cooperating firms and non cooperating firms in Ottawa (in percentage)

	HIGH AND MEDIUM TECH MANUFACTURING		KIBS	
	Cooperating firms (n=50)	*Non cooperating firms (n=14)*	*Cooperating firms (N=83)*	*Non cooperating firms (n=21)*
Firms' general characteristics				
Age (years)	17.1	18.2	15.2	19.7
Employees	56.9	36.2	34.0	35.6
Employees with university degree as % of total employment	42.2	38.7	52.1	61.5
Sales (000,000)	3.2	3.4	6.4 [b]	0.931
Exports	42.9	5.0	30.9	41.7
Innovation activities				
Internal R&D	86.0	69.2	79.0 [a]	42.9
External R&D	38.0	14.3	35.0	28.6
Acquisition of machinery, equipment and software	83.7 [a]	35.7	71.1 [a]	38.1
Acquisition of other external knowledge	44.9	23.1	53.8 [a]	14.3
Training	84.0	64.3	72.0	52.4
Innovation types				
New or significantly improved products	83.7	69.2	65.8 [a]	20.0
New or significantly improved services	51.0	38.5	67.5 [b]	42.9
New or significantly improved processes	55.3	8.3 [a]	41.1 [c]	16.7

Note: [a] Significant at the 1% level; [b] Significant at the 5% level; [c] Significant at the 10% level
Source: Ottawa ISRN firm survey, 2007

4.2 Occurrence and geographical distribution of cooperation

In addressing the issue of cooperation, the sample is now restricted to firms that cooperate. In the questionnaire, we asked the firms (i) whether or not they had maintained a cooperative relationship with a certain type of partner, which was focused on innovation activities; (ii) what types of knowledge sources they used; and, (iii) the location of their collaborators and knowledge sources. The study distinguishes between six types of collaborators and six types of knowledge sources: (i) customers; (ii) manufacturing suppliers; (iii) competitors; (iv) universities; (v) research labs; and, (vi) public agencies. The main locations of these different cooperators are then divided

between local (Ottawa-Gatineau region), regional; national (the rest of Canada); and international (anywhere outside Canada).

4.2.1 The occurrence of cooperation

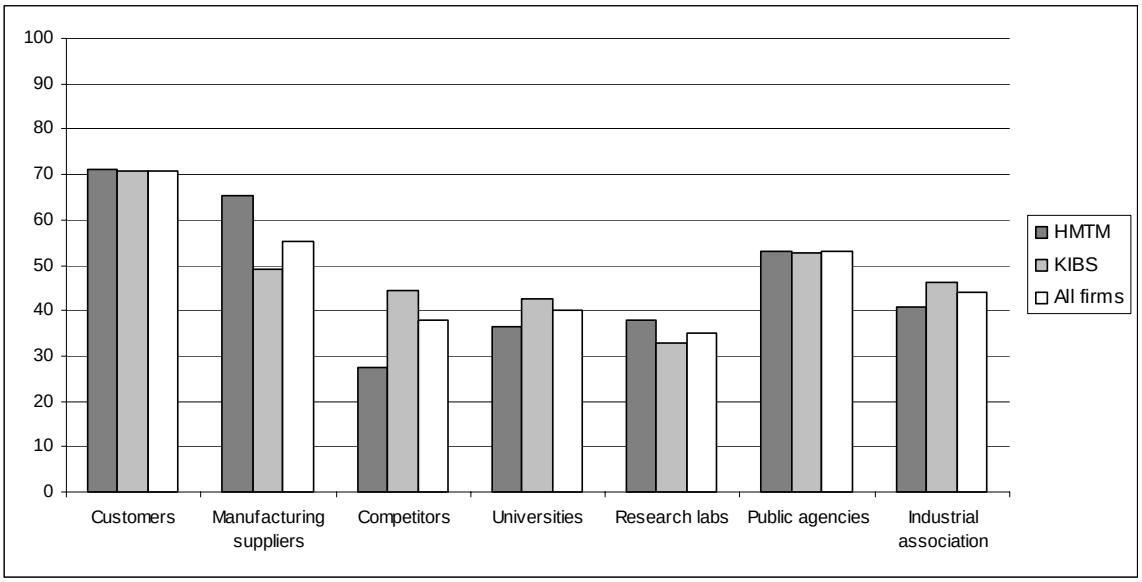
Figure 1 presents the results on collaboration for the total population and two cohorts. First of all, it must be stated that most of the firms interviewed are strongly engaged in innovation cooperation. As we can see in Figure 1, customers are the firms' most important collaborator, closely followed by suppliers. Suppliers are especially common collaborators for HMTMs. These relations should not only be regarded as hierarchical, they may very well include vertical value chains between suppliers and customers. In a sense, that is in line with the much quoted cluster diamond model (Porter 1998). This model claims that demanding customers and specialized suppliers are key components for deciding the long term competitiveness of firms.

The third and fourth most common collaborators are public agencies and industrial associations, which is surprising. The fact that a majority of firms have sustained a cooperative relationship to a public agency is indeed interesting but this may be more the result of an "Ottawa-effect" than a more general trend. Most of Canada's public agencies and industrial associations are located in Ottawa, so we would expect higher awareness of their existence among Ottawa firms compared to Canadian firms in general, and subsequently, higher interaction between such actors and Ottawa based firms.

Despite the fact that the region of Ottawa is well endowed with the concentration of knowledge-based organizations, universities and research laboratories, these are the least common collaborator. With a cooperation share of 43% regarding universities, KIBS are slightly more engaged in this kind of collaboration than HMTM, which, in turn, are more engaged in cooperation with research laboratories.

The results on the patterns of cooperation between HMTM and KIBS show little variance. With respect to the dominant cooperators, the results underline the importance of other firms along the value chain (customers and suppliers) and demonstrate that scientific knowledge organizations (universities and research laboratories) are of less importance. Compared to HMTM, a noteworthy result is that KIBS has an exceptionally higher rate of co-operation with other competitors, mainly other service firms, which is surprising considering that competitor cooperation is likely to be less frequent in services.

Figure 1. Firms' cooperation behaviors in Ottawa



Source: Ottawa ISRN firm survey, 2007

Tables 4a and 4b present correlation results between cooperative partners and innovation types in HTMF and KIBS. As we have already been pointed out, firms in general cooperate with partners from all six categories simultaneously. However, as we can see in Tables 4a and 4b, all collaborators are not equally important to the innovative activities of the studied firms. Starting with product innovation, there is no significant correlation between collaborative partners and this type of innovation within HMTM. In the case of process innovation, however, the opposite situation is evident. Here, there are no significant correlations for KIBS but process innovative HMTM collaborate with both customers and suppliers. For service innovation, suppliers are important to HMTM, while KIBS depend on customers, universities and government agencies.

Table 4a. Correlation between cooperative partners and innovation types (HMTM)

	Customers	Suppliers	Competitors	Universities	Res. Labs	Gov.	Prod. innov	Process innov.	Service innov
Customers									
Suppliers	0.799**								
Competitors	0.389**	0.448**							
Universities	0.411**	0.355**	0.386**						
Res. labs	0.427**	0.440**	0.434**	0.708**					
Government	0.609**	0.650**	0.372**	0.522**	0.610**				
Prod. Inno.	ns	ns	Ns	ns	ns	ns			
Proc. Inno.	.0325*	0.350**	Ns	ns	ns	ns	0.378**		
Service. Inno..	Ns	0.242*	Ns	ns	ns	ns	ns	ns	

* Significant at the 1% level; ** Significant at the 5 % level Not significant: ns

Source: Ottawa ISRN firm survey, 2007

Table 4b. Correlation between cooperative partners and innovation types (KIBS)

	Customers	Suppliers	Competitors	Universities	Res. labs	Gov.	Prod. innov	Process innov.	Service innov
Customers									
Suppliers	0.465**								
Competitors	0.490*	0.454*							
Universities	0.426**	0.264*	0.232*						
Res. Labs	0.319**	0.314**	0.302**	0.696**					
Government	0.639**	0.398**	0.463**	0.582**	0.543**				
Prod. Inno.	0.277**	ns	Ns	ns	ns	ns			
Proc. Inno.	ns	ns	Ns	ns	ns	ns	0.296**		
Service Inno.	0.242*	ns	Ns	0.228*	ns	0.200*	0.448**	ns	

* Significant at the 1% level; ** Significant at the 5 % level Not significant: ns

Source: Ottawa ISRN firm survey, 2007

The patterns in Tables 4a and 4b seem to suggest that innovation in the studied firms are driven by a rationale that is close to the everyday activities of the firm, as opposed to a more conscious 'let's go and discover new things' kind of rationale. Research laboratories are never a significant collaboration partner in the present material and universities only matter for service innovation in KIBS, which would suggest that the so often proclaimed importance of these actors to firms' innovation processes, is somewhat downplayed by this material.

In order to provide more insight into the determining factors for innovation in the surveyed firms, the following looks at the relationship between different types of knowledge sources in innovation activities.

4.2.2 Knowledge sources in innovation

Knowledge source in innovation is defined here as sources of information that the firm seek to use in the innovation processes. Table 5 reports on the knowledge sources in

innovation. In general, both HMTM and KIBS rely on a variety of knowledge sources to conduct innovation. This result is confirmed by the high percentage in the responses giving by firms to the question of where their ideas for innovation come from. A decomposition of the knowledge sources shows that for both HMTM and KIBS, the most important knowledge source are in house R&D and customers. The use in innovation of knowledge sources from suppliers, however, is found to be more important for HMTM.

There are interesting correlations between knowledge sources and innovation types (Tables 6a and 6b). To most firms, all types of knowledge sources studied here matters and there are no major differences between HMTM and KIBS in this respect. However, there are indeed differences between these types of firms when it comes to how important the respective knowledge sources are to innovation in the firms. A bit surprisingly perhaps, none of the here studied knowledge sources constitute a significant factor for innovation in HMTM. For KIBS, suppliers provide knowledge for product innovation and service innovation, and service firms constitute a significant knowledge source for service innovation. Furthermore, Tables 6a and 6b indicate that KIBS are more commonly engaged with all types of innovation while HMTM are more focused on one type of innovation, or process and service innovation simultaneously.

Table 5. Knowledge sources in innovation (%)

	HMTM	KIBS
In house R&D	84.8	82.1
Customers	83.8	79.2
Suppliers	57.6	45.3
Universities/research labs	43.9	46.2
Service firms	47.0	45.3

Note: [a] Significant at the 1% level; [b] Significant at the 5% level; [c] Significant at the 10% level
Source: Ottawa ISRN firm survey, 2007

Table 6a. Correlation between knowledge sources and types of innovation (HMTM)

	In house R&D	Customers	Suppliers	Univ/ res.labs	Service firms	Prod. Innov	Process innov.	Service innov
In house R&D								
Customers	ns							
Suppliers	ns	0.356**						
Universities/res.labs	ns		0.328**					
Service firms	ns		0.562**	0.451**				
Prod.innov	ns	ns	ns	ns	ns			
Process innov.	ns	ns	ns	ns	ns	ns		
Service innov.	ns	ns	ns	ns	ns	ns	0.378**	

* Significant at the 1% level; ** Significant at the 5 % level Not significant: ns
Source: Ottawa ISRN firm survey, 2007

Table 6b. Correlation between knowledge sources and types of innovation (KIBS)

	In house R&D	Customers	Suppliers	Univ/ res.labs	Service firms	Prod. Innov	Process innov.	Service innov
In house R&D								
Customers	ns							
Suppliers	ns	0.325**						
Universities/res.labs	0.236*	0.195*	0.525*					
Service firms	ns	0.372**	Ns	0.487**				
Prod.innov	ns	ns	0.259**	ns	ns			
Process innov.	ns	ns	ns	ns	ns	0.296*		
Service innov.	ns	ns	0.193*	ns	0.309**	0.448**	ns	

* Significant at the 1% level; ** Significant at the 5 % level Not significant: ns

Source: Ottawa ISRN firm survey, 2007

4.2.3 The geographical distribution of cooperation and knowledge sources

The final part of the empirical study is concerned with the geographical distribution of knowledge sources and collaborators. In general, for both collaboration and knowledge sources, a geographical pattern is visible in the material that assumes either a U-shape or the form of an inverted J. This means that the local level is always the most common area of collaboration and knowledge sourcing and that the international level is next in line for the majority of cases. The regional and national scale, however, are clearly not as important. It is perhaps not surprising that the local environment is the most relevant and important area of interaction since this is the context in which most actors operate on a daily basis.

We can assume, in line with the aforementioned 'local buzz and global pipelines' metaphor, the many actors will chose to interact with local partners on the basis that they are simply more likely to know about them, that it is more convenient, or that it allows more control to be exercised. It is not equally clear however, why firms would so typically choose international partners over regional and national ones. For some actors we can assume that the regional and national contexts do not provide a sufficient resource and knowledge base, but the fact that the pattern is so general across actor-types is harder to explain. Although there is some variation in the material, the international scale is only marginally less important than the national or regional in two cases for collaboration and in two cases for knowledge sources.

Most of the variation in the geographical distribution instead lies in whether the pattern assumes more of a U-shape, or more of an inverted-J shape. For some specific collaborators and sources (see Tables 7 and 8) the local and the international level are equal (and the pattern is then perfectly U-shaped) and for some the local level is more dominant (inverted J). There are also some noteworthy exceptions to this pattern which the following addresses in more detail.

Table 7 gives indications on the geographical distribution of cooperation by type of collaborators. This will allow us to know better on the extent to which a particular

partner is more locally embedded than another. Table 7 shows that the proportion of local collaborators is more important for KIBS compared to HMTM, which in turn, use more collaborators located outside Canada in the cases of customers, suppliers and competitors. However, the proportions of regional and national collaborations used of all type are uniformly less than those at the local and international levels, and this hold tru for both HMTM and KIBS.

When comparing the results, the pattern of collaboration in the innovation process is different between HMTM and KIBS. The geographical pattern is taking a U-shaped for HMTM but assumes an inverted J shape for KIBS. This would suggest that the latter category operate on a more distinct local basis. The data show also a more compressed shape for competitors, which could mean a higher awareness among HMTM and KIBS about competitors than about other related actors.

Table 7. Geographical distribution of cooperation by type of collaborators

	Ottawa	Regional	Canada	International
High and medium tech manufacturing (n=223 collaborations)				
Customers	46.8%	0.0%	6.4%	46.8%
Manufacturing suppliers	47.6%	9.5%	7.1%	35.7%
Competitors	36.0%	12.0%	12.0%	40.0%
Universities	63.6%	4.5%	4.5%	27.3%
Research Labs	64.0%	4.0%	8.0%	24.0%
Public agencies	85.7%	2.9%	2.9%	8.6%
Industrial associations	77.8%	3.7%	0.0%	18.5%
KIBS (n=384 collaborations)				
Customers	63.6%	1.3%	9.1%	26.0%
Manufacturing suppliers	68.5%	3.7%	11.1%	16.7%
Competitors	47.0%	13.6%	12.1%	27.3%
Universities	72.3%	8.5%	12.8%	6.4%
Research Labs	77.1%	8.6%	5.7%	8.6%
Public agencies	85.7%	3.6%	7.1%	3.6%
Industrial associations	69.4%	2.0%	12.2%	16.3%

Source: Ottawa ISRN firm survey, 2007

Table 8 shows the geographical distribution of knowledge sources for innovation activities. These data shows that the situation is slightly different for knowledge sources, although the U-/inverted J- shape is visible also here. The clearest difference is that both HMTM and KIBS are less international in their knowledge sourcing from research universities and laboratories than they are when it comes to collaboration with such partners. However, the general differences between HMTM and KIBS that we see for collaboration remain the same when we look at the knowledge sources that firms use.

Table 8. Geographical distribution of knowledge sources for innovation activities

	Ottawa	Regional	Canada	International
HMTM (n=266)				
Customer	47.7%	4.6%	4.6%	43.1%
Supplier	50.0%	13.0%	4.3%	32.6%
Research universities and public labs	68.8%	18.8%	0.0%	12.5%
Consultant firms	78.8%	9.1%	6.1%	6.1%
Commercial R&D	64.5%	6.5%	3.2%	25.8%
KIBS (n=406)				
Customer	58.8%	7.2%	11.3%	22.7%
Supplier	64.8%	9.3%	7.4%	18.5%
Research universities and public labs	78.8%	13.5%	5.8%	1.9%
Consultant firms	82.7%	9.6%	3.8%	3.8%
Commercial R&D	66.0%	5.7%	11.3%	17.0%

Source: Ottawa ISRN firm survey, 2007

6. Summary and conclusion

Regarding the research questions introduced at the beginning of this paper, the results of this study can summarized as follows:

1. Relative to the characteristics of cooperative firms compared to non-cooperative firms, the results suggest that they are no significant difference between the two groups of firms with regard to firms' characteristics such as age, size, employees, sales and exports. Significant differences exist between cooperative firms and non-cooperative firms with respect to innovation activities. For both HMTM and KIBS, cooperative firms introduced more frequently new or significantly improved products, processes and services innovation than they counterpart.

2. As for the importance of cooperation and the types of partners for innovation activities, the results reveal that most firms active in innovation activities are strongly involved in cooperative relationships with market, research and public organizations. However, all cooperators are not equally important for innovation. The most important cooperators for the innovation activities of firms' sample are the customers and suppliers, while knowledge generators such as universities and research labs are of less importance.

3. Of all sources of knowledge used by firms, customer does represent an important channel for acquiring information and knowledge for both HMTM and KIBS. Their share is higher than of suppliers, universities and other service firms.

4. Relative to the geographical distribution of cooperation, the results suggest strongly that firms in the Ottawa innovation survey used local and international collaborations which were used more than those associated to provincial and national collaborations. Most of the variation in the geographical distribution of cooperators lies in whether the pattern assumes more of a U-Shape for HMTM in general; and cooperation with customers and suppliers in particular. For KIBS, the pattern assumes an inverted J-Shape in general and cooperation with competitors in particular. Most of cooperative links with research and public organizations cooperative are strongly embedded within the region of Ottawa.

5. Relative to the cooperative links between the two sectors analyzed, only minor difference were found to exist between the two cohorts and therefore HMTM are quite similar to KIBS regarding their pattern of cooperation. However, they are significant statistical differences between the two groups of firms. Whereas for HMTM firms the most important cooperators are other firms along the value chain (customers and suppliers), KIBS firms, thus rely more on customers, competitors and universities. There are also significant statistical differences between types of cooperative partners and innovation types. Whereas process 'new or slightly improved' correlates significantly with customers and suppliers cooperation for HMTM, services 'new or slightly improved' correlate significantly with customers, universities and government for KIBS. Significant correlations can also be found between the types of knowledge sources and types of innovation. However, more positive correlations are found for KIBS compared to HMTM. As for cooperation, KIBS cooperate more than HMTM and with more partners. However, the geographical patterns of cooperation differ slightly between the two groups of firms. Cooperation from the region, in particular universities, research labs as well as public agencies and industrial associations, are clearly more important for KIBS. However, HMTM are cooperating more with local and international partners than on regional and national ones. The same holds true for the sources of knowledge used by HMTM in their innovation activities: highly internationalized are in particular for knowledge sources from customers and supplier compared to KIBS which are using more local knowledge sources, including universities, research labs and other consultant firms.

The empirical results indicate that innovative cooperation in knowledge-intensive industries, both manufacturing and service firms, is a complex phenomenon. They are engaged in various types of innovation activities, use various types of knowledge sources and rely on different partners to exchange information in order to be more innovative. Also, the result show that innovative cooperative between knowledge intensive industries and external actors take place at the local, regional, national and international level. Thus, there are valid arguments to sustain the hypothesis that for both innovative firms and innovative regions, knowledge-transfer and learning processes confined exclusively to the local scale and communication via face-to-face interaction are no longer a sufficient basis for developing and maintaining competitive advantage grounded in tacit knowledge. If we acknowledge the fact that innovative firms are connected and tap into different systems of innovation to acquire both codified and tacit knowledge, then it is important to recognize that different systems of innovation – local, national,

international- are strongly interconnected. What seems important now is to sort out more systematically the relationship between spatial scales – in particular, the relative importance of regional, national, and international forces in economic and innovation processes. What is also clear is that explanations based on only a single scale of analysis will be likely to prove inadequate.

The issues raised in this paper also lead to a broader set of questions which will require further investigation -- namely, how the sources and types of knowledge exchanged and the cooperative links differ across different types of regions and, how different regions adapt and generate certain forms of knowledge and to what extent similar – or different- regions connect to each other. Following Tödtling et al. (2006), there is a need not only to clarify the types of cooperation and their geography, but also to analyze whether they differ across regions. On this basis, it would be possible to develop a more discriminating account of the conditions that enable some industries as well as regions to adapt, generate and tap to certain forms of knowledge more successfully than others.

References

Amin, A. and Thrift, N. (2002), *Cities. Reimagining the urban*. Polity, Cambridge

Asheim, B.T. and M. S. Gertler (2005) Regional Innovation Systems and the Geographical Foundations of Innovation. In J. Fagerberg, D. Mowery and R. Nelson (eds.), Oxford Handbook of Innovation. London: Oxford University Press.

Asheim, B. T. and Lars Coenen (2005) Knowledge bases and regional innovation systems: Comparing Nordic clusters, Research Policy, 34, 8, 1173-90

Asheim, B.T and A. Isaksen (2002) Regional Innovation Systems: The Integration of Local 'Sticky' and global 'ubiquitous' Knowledge, Journal of Technology Transfer, 27, 77-86.

Bathelt, H., A. Malmberg and P. Maskell (2004), Clusters and knowledge: local buzz, global pipelines and the process of knowledge creation. *Progress in Human Geography*, 28, 1: 31-56

Becatini, G. (2004) Industrial districts: a new approach to industrial change, Edward Elgar Publishing: London.

Britton, J. N. H. (2004) High technology localization and extra-regional networks, Entrepreneurship and Regional Development, 16, 369-90.

Britton, J. N. H., 2007. Path dependence and cluster adaptation: a case study of Toronto's new media industry. International Journal of Entrepreneurship and Innovation Management, 7 (2/3/4/5):

Bunnell, T. G. and N. M. Coe (2001) Spaces and scales of innovation, Progress in Human Geography, 25(4): 569-89.

Chamberlin and de la Mothe, 2003

Cooke, P., M. Heidenreich and H-J. Braczyk (2004) Regional Innovation Systems: The Role of Governances in a Globalized World. London: Routledge.

Crevoisier, O. (2004) The innovative milieus approach: toward a territorialized understanding of the economy? Economic Geography, 80 (4): 367-379.

Cumbers, A., D. MacKinnon and K. Chapman (2003) Innovation, collaborations, and learning in regional clusters: a study of SMEs in the Aberdeen oil complex, Environment and Planning A, 35, 1689-706.

Dahlander, L. and M. McKelvey (2005) The occurrence and spatial distribution of collaboration: biotech firms in Gothenburg, Sweden, Technology Analysis and Strategic Management, 17 (4): 409-431.

Dicken, P, and A Malmberg. 2001. Firms in territories: a relational perspective. Economic Geography:345-363.

Diez, J.R. (2000) Innovative networks in manufacturing: some empirical evidence from the metropolitan area of Barcelona, Technovation, 20: 139-150.

Doloreux, D. (2004a) Regional innovation systems in Canada: a comparative study, Regional Studies, 38, 5, 479-92.

Doloreux, D. (2004b) Regional networks of small and medium sized enterprises : evidence from the metropolitan area of Ottawa in Canada, European Planning Studies, 12, 2, 173-89.

Doloreux, D. (2002) What we should know about regional systems of innovation, Technology in Society: An International Journal, 24: 243-263.

Freel, M. (2003) Sectoral patterns of small firm innovation, networking and proximity, Research Policy, 32: 751-770.

Freel, M and R. Harrison (2006) Innovation and cooperation in the small firm sector: evidence from 'Northern Britain', Regional Studies, 40 (4): 289-306.

Gertler, M. (2003) Tacit knowledge and the economic geography of context, or the undefinable tacitness of being (there), Journal of Economic Geography, 3 (1):

Gertler, M. and Y. Levitte, (2005) Local nodes in global networks: the geography of knowledge flows in biotechnology innovation, Industry and Innovation, 13: 487-507.

Gertler, M. S. and D.A. Wolfe (2006), Spaces of knowledge flows. Clusters in a global context. In Asheim, B., Cooke, P. and Martin, R. (Eds.), *Clusters and Regional Development. Critical reflections and explorations*. Routledge, London (218-235).

Grotz, R. and B.Braun (1997) Territorial or trans-territorial networking: spatial aspects of technology-oriented co-operation within the German mechanical engineering industry, Regional Study, 31 (6): 545-

Kalafsky, R. and A. MacPherson (2002) The competitive characteristics of US manufacturers in the machine tool industry, Small Business Economics, 19, 4, 355 69.

Koschatzky, K., Kulicke, M. and A. Zenker (2001) Innovation networks: concepts and challenges in the European perspective, Fraunhofer, Physica-Verlag.

Hendry, C. Brown, J. and R. defillippi (2000) Regional clustering of high technology-based firms: opto-electronics in three countries, Regional Studies, 34 (2): 129-144.

Holbrook, J.A.D. and D.A. Wolfe (2005) The Innovation Systems Research Network (ISRN); A Canadian experiment in Knowledge Management, Science and Public Policy, 32 (2):

Lundvall, B-Å. (1992) Introduction. In Lundvall, B-Å. (Eds.) National Systems of Innovation. Towards Theory of innovation and Interactive Learning. Pinter, London.

Madill, J.J., Haines, G.H. and A.L.Riding (2004) Networks and linkages among firms and organizations in the Ottawa-region technology cluster, Entrepreneurship and Regional Development, 16: 351-368.

Maskell, P. and A. Malmberg (1999) Localised learning and industrial competitiveness, Cambridge journal of economics, 23 (2): 167-86.

Maskell, P. and L. Kébir 92006) What qualifies as a cluster theory? In B. Asheim, P. Cooke, R.Martin, Clusters and regional development: critical reflections and explorations, Routledge: London.

Mattsson, H. 2007. Locating Biotech Innovation: Places, Flows and Unruly Processes. Uppsala University Press.

Moulaert, F. and F. Sekia (2003) Territorial innovation models: a critical survey, Regional Studies, 37(3): 289-302.

Nachum, L. and D. Keeble (2003) Neo-marshallian clusters and global networks: the linkages of media firms in central London, Long Range Planning, 36: 459-480.

Oerlemans, L.A.G. and M.T.H. Meeus, (2005) Do organizational and spatial proximity impact on firm performance? Regional Studies, 39 (1): 89-104.

Oinas, P. and E. J. Malecki (2002) The evolution of technologies in time and space: From national and regional to spatial innovation systems, International Regional Science Review, 25 (1): 102-31.

Pittaway, L., Robertson, M., Munir, K., Denyer, D. and A. Neely (2004) Networking and innovation: a systematic review od the evidence, International Journal of Management Reviews, 5/6 (3/4): 137-168.

Shavinina, L.V. (2004) Silicon Valley North, Elsevier: Amsterdam.

Simmie, J. (2004) Innovation and clustering in the globalised international economy, Urban Studies, 41 (5/6): 1095-1112.

Sternberg, R. (1999) Innovative linkages and proximity: empirical results from recent surveys of small and medium sized firms in German regions, Regional Studies, 33 (6): 529-540.

Storper, M, and A Venables. 2004. Buzz: face-to-face contact and the urban economy. Journal of Economic Geography 4:pp 351-370.

Suarlez-Villa, S and W. Walrod (1997) Operational Strategy, R&D and intra-metropolitan clustering in a polycentric structure: the advanced electronics industries of the Los Angeles, Urban Studies, 34 (9): 1343-1380.

Tödtling, F., Lehner, P. And M. Trippl (2006), Innovation in knowledge intensive industries: the nature and geography ok knowledge links, European Planing studies, 14 (8): 1035-1058

Tödtling, F and M. Trippl (2007) International journal of entrepreneurship and innovation management, 7 (2\3\4\5):

von Hippel, E. 1988 *The Sources of Innovation*. Oxford: Oxford University Press.

Wolfe, D. A. And M.S. Gertler (2004) Clusters from the inside and out: local dynamics and global linkages, Urban Studies, 41(5/6): 1071-109

Wood, A., Watts, H.D. and P. Wardle (2004) Growth-oriented small firms and the nature and extent of local embeddedness: The case of a traditional metal working cluster, Growth and Change, 35: 419-433.