Neo-Regionalism and Spatial Analysis : Complementary Approaches to the Geography of Innovation?

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Abstract: Since the mid-1990s when the idea of regional innovation systems were introduced there have been a multitude of research projects seeking to identify and qualify the spatial mechanisms and factors that lead to firm-level innovation from a neo-regionalist perspective. More recently there has been some questioning as to the way in which geographic proximity should be conceptualized in order to capture the correct scale and mechanisms most propitious to regional innovation. In this paper, drawing upon spatial analytical concepts developed by geographers, urban analysts and by certain students of innovation, I suggest that an alternative way of conceptualizing the connection between space and innovation is to investigate space as a continuous field of opportunities. I show that, depending on what type of innovation is considered, both the neo-regionalist and the spatial-analytic approaches are corroborated. This leads to the concluding suggestion that certain spatially distributed factors, such as transport infrastructure and basic services, are important enablers of the proximities necessary for innovation.

1. Introduction

It is now well accepted that innovation at the firm level is not solely attributable to entrepreneurship or to in-house activities, but is also a social process (EDQUIST, 1997; LUNDVALL, 1992). Whilst some firms exhibit a greater or lesser internal capacity to innovate, this capacity is also determined by the networks and environment within which they operate. Indeed, part of a firm's internal capacity to innovate is now considered to be the degree to which it is capable of entering into and benefiting from information exchange and collaboration with its environment. Thus, innovation is understood as a social process, and increasingly research is devoted to understanding the way in which factors external to firms contribute to their innovative behavior.

Despite this consensus, there is considerable debate over the nature of external factors that can contribute to innovation. A series of distinct but overlapping arguments put forward factors such as knowledge spillovers (JAFFE, 1989), social networks (CAMAGNI, 1995), organizational proximity (BOSCHMA, 2005), institutions (MORGAN, 1997), market transactions with suppliers and clients (ROTHWELL, 1992) and so on. These can almost all be subsumed under the more general term of untraded interdependencies (STORPER, 1995). It is also argued that geographic proximity plays a role because it enables or strengthens the effect of these factors.

In this paper I focus upon the connection between geography and innovation, and seek to answer a simple question: are firms more innovative in some places than in others? The simplicity of the question should not mask the fact that relatively little is known about the actual geography of innovation. As BOSCHMA (2005) points out, there is little empirical evidence relating to the existence (or not) of a geographic effect. This is partly due to problems inherent in the way regions and space have been conceptualized in innovation studies (MARKUSEN, 1999), and partly due to lack of comprehensive data on firm-level innovation. Almost out of necessity investigations that seek to understand the link between firm-level innovation and geography proceed by way of surveys that are not comprehensive in their coverage and that are rarely representative across space.

The structure of this paper is as follows. The first section briefly summarizes the various ways in which firms draw upon their external environment in order to further their innovative activities. The second section focuses on the reasons why spatial proximity may matter and, more importantly, on the way in which space has usually been conceptualized in innovation studies: this has most often been by way of clusters, regional innovation systems or milieux, all of which are physically bounded and which can be reduced to an 'in or out' dichotomy (TORRE & RALLET, 2005), an approach that I refer to as neo-regionalist. The third section will point to a small number of papers that have begun to conceptualize space in an alternative fashion, but most often without access to data to back up their arguments (McCANN, 2007; ANDERSSON & KARLSSON, 2004): these authors introduce space as a continuous surface of potential, in a spatial-analytic manner very similar to that of classical location theorists such as WEBER (1929) and CHRISTALLER (1966), except that it is potential access to *factors of innovation* (and not only to inputs, markets and clients) that matters. The empirical part of the paper rests on an innovation census of manufacturing establishments of over 20 employees conducted in Quebec broadly following Oslo Manual standards. With these data I seek to identify which of the neo-regionalist or the spatial-analytic approaches provides the best explanation of the geography of innovation in Quebec. I show that both conceptualizations of space are valid, but that each is valid for a different type of innovation.

2. Innovation as a social process

The classic understanding of innovative processes in firms is derived from SCHUMPETER (1934) who explains how entrepreneurs identify new technologies and transform them into profitable business opportunities. In larger firms, this linear process could be completely internalized with in-house researchers producing technological advances that are exploited by engineering and marketing departments, whilst amongst smaller firms complementarities may develop between different innovations leading to a clustering in time and in particular sectors (ROTHWELL, 1992). However, by the early 1980s this stylized innovation process was found wanting by many analysts who observed the importance of feedback from clients and suppliers (ROTHWELL, 1992; MALECKI, 1997). Innovation was increasingly understood as an iterative process drawing on outside information.

This new way of understanding the innovation process sparked a large amount of research on the nature and sources of outside information and feedback, an area of research that is still very active today. A variety of approaches have developed, and I can only briefly overview some of the principal ones below. The aim of this overview is not to provide in-depth analysis of each approach, but to introduce the type of mechanism posited.

The idea that there exist national systems of innovation, structured by education systems, technical and scientific institutions, policies and culture (LUNDVALL, 1992; FREEMAN, 1995) was derived from institutional economics. Under this approach it is suggested that certain types of institutional environment are better adapted to providing firms with qualified labor, tax incentives, knowledge and access to primary research, all of which are conducive to innovation.

JAFFE (1989) pinpointed another important – and more direct – source of outside information, that of localized knowledge spillovers. According to him, evidence from patent citations demonstrates a tendency for innovative firms (those issuing patents) to draw more heavily from other patents issued locally; this has been attributed to the existence of local knowledge spillovers. The spatial extent of these spillovers is a matter of current debate (BRESCHI & LISSONI, 2001; TAPPEINER et al, 2008).

Exchange of knowledge is an important factor in the social innovation process, and patent citations are not the best indicator of day-to-day knowledge flows. Indeed, knowledge can be roughly categorized as codified (embedded in patents, books, manuals, reports) or tacit (embedded in people or in organizations, and either difficult to codify or not codified because of lack of incentive) (BRESCHI & LISSONI, 2001). The exchange of codified information is relatively easy, and increasingly so with new telecommunication technologies (MASKELL & MALMBERG, 1999). Tacit information, on the other hand, requires either requires face-to-face or some other type of proximity, such as social or institutional (GERTLER, 2003; BOSCHMA, 2005).

This leads into debates on whether knowledge spillovers, or, more generally, the exchange of tacit information and know-how, are necessarily local (BRESCHI & LISSONI, 2001; GERTLER, 2003; TORRE & RALLET, 2005). BOSCHMA (2005) has recently reviewed a variety of conceptualizations of proximity, of which he identifies five: i) cognitive (sharing a common vocabulary and conceptual framework); ii) organizational (capacity to coordinate and exchange knowledge); iii) social (micro-level social ties of friendliness and trust); iv) institutional proximity (macro-level routines, rules and regulations); and v) geographic proximity. Thus, the idea that proximity facilitates the acquisition of information for a firm has been understood from a variety of perspectives. However, there is debate as to whether some types of proximity matter more than others, in particular the possible primacy of social proximity over physical proximity. There is agreement, though, on the necessity for firms to be proximate *in some way* to other economic actors in order to acquire the tacit knowledge and feedback which are inputs to the firm's own innovation process.

Finally, the function of producer services (or Knowledge Intensive Business Services) is to transfer information, knowledge and know-how. There is thus a direct market in knowledge that contributes to the innovative capacity of firms (DEN HERTOG, 2000).

Although this overview is not exhaustive, and has avoided entering into details of the ideas alluded to, it has served to highlight two things. First, current research on innovation focuses heavily on innovation as a social process, and particularly on the ways in which knowledge and know-how are exchanged and acquired by innovative firms. Second, the importance of institutions and of the exchange of tacit information has led some researchers to introduce geographic proximity as an enabling – if not as a causal – factor. It is to this that we now turn in more detail.

3. Geography and innovation: the triumph of neo-regionalism

As a number of researchers have pointed out (MARKUSEN, 1999; MOULAERT & SEKIA, 2003), there is some confusion over the link between innovation and space. This confusion stems from two related sources. First, there is lack of conceptual clarity over a number of spatial concepts that have been introduced (MARKUSEN, 1999). Second, a wide variety of such concepts exist (MOULAERT & SEKIA, 2003).

Innovative milieux (MAILLAT et al, 1993), regional innovation systems (COOKE et al, 1997), industrial districts (PIORE & SABEL, 1984), learning regions (FLORIDA, 1995) and regional clusters (PORTER, 2003) have all been suggested, not only as different terms for, but also as different concepts of, dynamic regional economies. Each concept highlights different mechanisms whereby regions provide or generate the conditions necessary for innovation and growth. Innovative milieux stress local culture, traditions and trust, which lead to knowledge exchange and collaboration between firms. Regional innovation systems place emphasis on local institutions and culture. Industrial districts draw upon the ideas of MARSHALL (1890) and give more importance to supplier and client relationships within specific sectors, division of labour and shared labour markets. The learning region idea emphasizes regional capacities to capture and utilize codified and tacit knowledge, and highlights the role of research institutions and qualified workers. Regional clusters put forward the idea of regional competitive advantage, constructed locally by strategic specialization, inter-firm collaboration and competition, and by policies (such as education and specialized infrastructure) conducive to enhancing this specialization.

As MOULAERT & SEKIA (2003) point out, these various ideas, whilst different, are also connected, and each seems to focus on a particular dimension of a wider whole. It is probably the partial nature of these concepts, associated with the difficulty of devising methods to test their generality, that is behind MARKUSEN'S (1999) description of geographers' and planners' work on industrial districts, and in particular their emphasis on networks and co-operative competition, as an example of 'fuzzy conceptualisation' (p183).

In order to consider the impact of geography, if any, on firm-level innovation it is worth taking a step back from this rather confusing array of spatial mechanisms and concepts. If one returns to the literature on innovation, it is clear that there exist a variety of ways through which firms may acquire the information, knowledge and other inputs necessary for successful innovation. It is also clear that the acquisition of these inputs is not *necessarily* determined by regional factors: however, it *may* be, at least in part. Proximity to other economic actors and institutions *may*, through a variety of mechanisms, lead to an increased propensity to innovate. Each of the concepts outlined above can thus be seen as a particular example of a mechanism that *may* be enabled or facilitated by the right regional context. If this general proposition is correct, then it may also be true that different mechanisms operate in different territories. Each mechanism has been well documented, as MARKUSEN (1999) suggests, by in-depth case studies and survey work of particular regions. However, none has been successfully generalized – not through lack of data, but probably because there *is* nothing to generalize (TÖDTLING & TRIPPL, 2005; MORGAN, 2004). As SHEARMUR et al (2007) show, processes of regional development tend to vary not only across time, but also across space.

Having said this, all approaches to innovation and space outlined above have one thing in common: the way in which regions are conceptualized. Researchers who argue that geographic proximity matters see regions as bounded by frontiers, and hark back to STORPER's (1995) view that the region has a 'central theoretical status in the process of capitalist development which must be located in its untraded interdependencies' (p211). As TORRE & RALLET (2005, p49) put it when summing up the literature on innovation and proximity: 'Geographical proximity … is binary …The purpose of examining geographical proximity is to determine whether one is 'far from' or 'close to'.' In their recent review of the geography of innovation, ASHEIM & GERTLER (2006) make exclusive reference to this type of geography, which I will henceforth refer to as neo-regionalism.

An important question to which no clear response is given is the nature of the region (MORGAN, 2004; DOLOREUX & PARTO, 2005): at what scale does a regional innovation system or a regional cluster occur, and how does one identify its borders? On the one hand, and especially from the institutional perspective, administrative regions are often considered since such regions are assumed to share institutions and certain common cultural elements (COOKE et al, 2004). On the other hand, and somewhat tautologically, regions are loosely defined as spatial entities within which the requirements for proximity (and hence knowledge exchange, collaboration, cooperation etc…) are met. ROSENFELD's (1997) description of business clusters exemplifies this type of circular logic. For him, a cluster is:

> 'A geographical bounded concentration of similar, related or complementary businesses, with active channels for business transactions, communications and dialogue that share specialised infrastructures, labour markets and services, and that are faced with common opportunities and threats'. (p10)

A cluster is a 'bounded concentration', and a 'bounded concentration' is a cluster: the region is therefore the space within which cluster dynamics occur. Without explicitly recognising it, the concept of region applied in innovation studies seems to draw upon MASSEY's (1995, 2005), for whom spatial patterns *reflect* social and economic processes: from this point of view, the 'region' has no existence except for the fact that certain processes take place across a given space that temporarily becomes a 'region' for the duration of the process. GERTLER (2003) makes a related point when he emphasises, in his discussion of one of these processes (the transmission of tacit knowledge), that context is *produced* and not given:

> '...students of innovation need to consider more carefully how tacit knowledge and context are *produced* before we can say anything intelligent about the conditions under which tacit knowledge can most readily be shared – that is when 'proximity' is important…'(p95, emphasis in the original).

There is thus an inherent ambiguity in the neo-regionalist approach to innovation, since regions (i.e. particular spatial units) are usually taken as the starting point for studying localised innovation processes but can also be seen as the (temporary) end result of these processes.

Indeed, the question of how a region is defined for the purposes of innovation studies has increasingly been raised over the last few years (DOLOREUX, 2004; DOLOREUX & PARTO, 2005; FREEL, 2003; MORGAN, 2004). It has become clear that whatever the type of regional dynamic that is posited, this dynamic is not bounded by regional frontiers. DOLOREUX (2004), for instance, shows how the innovation system of a small rural region in Quebec is intensely connected with institutions in Quebec City, about 100km away. FREEL (2003) demonstrates that key sources of information and collaboration are sought at the national or at the global scale, local interactions tending to be for non-strategic purposes. TORRE & RALLET (2005) question whether geographic proximity is indeed of importance for knowledge exchange, and TORRE (2008) suggests that a time dimension should be added: proximity at a given point in time is important, but this can be during trade shows (for inter-firm collaboration), at college (for the creation of social networks), or during meetings of varying length (a few hours, a day, a few weeks…). Without rejecting the importance of geographic proximity in the sense of temporary co-location, TORRE (2008) qualifies it to such an extent that the notion of 'region' is scarcely applicable.

BATHELT et al (2004) build upon some of these observations when they augment the neo-regionalist perspective by adding the concept of global pipelines. For them, there exists a local 'buzz' that encompasses many of the local networking and knowledge exchange mechanisms described above. Regions are also connected to other regions across the globe by privileged 'pipelines' of information. This resembles CASTELLS' (1996) idea of a networked economy, with certain 'buzzing' regions acting as nodes in a global space of connecting flows.

Questions of regional scale, of links between regions, and of whether or not regions play a role in innovation are now common. However, although conceptualisation of the region is becoming more complex, the underlying geographic approach has not really evolved. Regions (defined at whatever sub-national scale the researcher finds appropriate) are still assumed to possess certain unique qualities. These qualities lead to innovation amongst firms in the region, and they do not lead to innovation in firms outside the region. Regions are seen as individuals[1]: just as a person's characteristics (education level, intelligence, physical build) are usually not shared with another individual, so a region's characteristics (local networking, institutions, tacit knowledge, clusters) have little or no effect on another's. Innovative regions are 'islands', part of an innovative 'archipelago' in the new global economy (VELTZ, 1996).

4. Return to location theory: a spatial analytic approach

Somewhat paradoxically for a body of work sensitive to the role of institutions and history, the neo-regionalist approach to the geography of innovation may be suffering from institutional lock-in. Indeed, there is a long tradition, in geography, of viewing regions as unique. From the late nineteenth century, and up to the Second World War, regional geography – often referred to as regionalism - consisted in producing detailed monographies describing the physical, human and economic particularities of each region (LIVINGSTONE, 1992). Following a decade of heated debates, the 'quantitative

[1] STORPER (1995) argues that the region should be considered a 'fundamental unit of social life' (p191)

revolution' took hold in the 1960s – geography, and particularly economic geography, became the study of spatial models of diffusion, gravity models and distance decay (LIVINGSTONE, 1992; FOTHERINGHAM et al, 2000). Many of these spatial analytic models begin with the assumption of isotropic space, and explore the location of economic activity assuming various discontinuities (the presence of inputs, the presence of markets, transport costs): they rest on classic spatial theories developed by von Thünen, Lösch, Christaller and Weber (DICKEN & LLOYD, 1990). In the 1980s, in the face of what many geographers saw as the over-quantification of geographic analysis, economic geography returned to a more regionalist approach, as described and encouraged by STORPER (1995) who is strongly connected with the idea of regions as 'the nexus of untraded interdependencies'[2]. In particular, regional development is increasingly seen as depending on the interaction between local territorial dynamics and fundamental social changes such as globalization, tertiarisation or the imperative to innovate, which have no necessary spatial structures (SCOTT and STORPER, 1985): thus, for regions, development depends on their particular social, cultural and institutional processes and on their particular factors of production.

In this context, it can better be understood why innovation studies has tended to adopt the neo-regionalist approach and not the spatial-analytic one. At the time when ideas about innovation systems were being put forward in the 1980s and early 1990s, economic geographers were interested in local territorial dynamics. To the extent that a connection was made between innovation and space at that time, economic geography was geared towards understanding the nature of local factors conducive to innovation.

It is only recently that a spatial analytic approach has tentatively appeared in the context of innovation studies. In 2004 ANDERSSON & KARLSSON published a chapter in which they suggest that space should be viewed as a field of potential. They argue that geographic space is a continuum, and that each point in space is characterised by its accessibility to all others. From the point of view of innovation, they suggest that certain locations are more propitious to innovative activities than others, not because of their intrinsic characteristics, but because they provide better access to innovation inputs

[2] It should be pointed out that STORPER (1995) believes that by providing a theoretical framework for this neo-regionalist approach he can enable certain generalisations and comparisons to be made across regions.

(which are not necessarily local). McCANN (2007) has recently developed a spatial model of innovation by adapting von Thünen's model (DICKEN & LLOYD, 1990): assuming that different types of innovation require different intensities of face-to-face interaction, and assuming that metropolitan areas are key foci for this interaction (CREVOISIER & CAMAGNI, 2001), he shows that a self-organising spatial process will lead different types of innovative activity to locate at different distances from core metropolitan areas.

These two conceptualisations of the connection between geography and innovation have in common that neither refer to the intrinsic qualities of the location where innovation takes place, but both suggest that innovation will take place in certain locations depending on their position *relative* to key determinants of innovation[3].

These concepts are not new: geographic research on the determinants of regional growth and of agglomeration economies often recognises the importance of accessibility between regions (and not just regional characteristics themselves) to obtain some understanding of the spatial system writ large (SHEARMUR & POLÈSE, 2007; PRED, 1973; PHELPS & OZAWA, 2003). What is new is the fact that researchers interested in the geography of innovation are beginning to consider that spatial analytic approaches may yield some insights over and above those already provided by neo-regionalists.

From an empirical perspective it is often difficult to conduct spatial analyses of innovative activities due to data limitations: indeed, few surveys are planned in such a way as to ensure spatial (as well as sectoral, firm size etc…) representativity. The few studies that look at space as a continuum generally focus on knowledge spillovers. For instance MAGGIONI et al (2007) investigate whether the spatial auto-correlation of patenting activity in Europe is attributable to spillovers between regions or to the spatial distribution of innovation inputs. They find that once local regional input factors are accounted for there are few spillovers, with one important proviso: distance from

[3] The only area related to innovation studies in which a spatial analytic approach is relatively common is the study of knowledge spillovers, usually proxied by the study of patents and co-patenting (e.g. MAGGIONI et al, 2007; GREUNZ, 2004). BRESCHI & LISSONI (2001) argue that is a very specific area of study. This body of work has not (yet?) fundamentally modified the geographic conceptualisations that prevail in innovation studies, partly because results relating to the distance over which knowledge is transmitted are inconclusive, and partly because patents are a very specific type of (major) innovation.

Brussels is a determinant of patenting activity irrespective of local attributes. They therefore find some limited evidence for the spatial-analytic approach, but principally confirm the regionalist view. In a similar study TAPPEINER et al (2008) attribute all observed spatial auto-correlation of patent applications to the underlying distribution of local inputs.

Given the predominance of neo-regionalism in innovation studies, the purpose of this paper is to investigate whether evidence can be found that a spatial-analytic approach can provide new insights. The research question that I address is the following: does innovation in manufacturing firms vary across space in Quebec? If so, does firm-level innovation vary with distance from a metropolitan area, or does it vary as a function of local regional attributes?

Following McCANN's (2007) model and MAGGIONI et al's (2007) results, I hypothesise that innovation will vary with distance from major metropolitan areas: whether innovation is thought to depend upon institutions, knowledge spillovers, universities, business services, key labour inputs or infrastructure (such as airports), all of these are more accessible in Quebec's major metropolitan areas. Given that certain institutions (such as universities) are also present elsewhere, I also hypothesise that innovation may vary with distance from small metropolitan areas. If regional attributes are introduced, I hypothesise that they may weaken, but will not override, the spatial patterns.

5. Data and methodology

This study is based upon the 2005 Innovation Survey of manufacturers conducted by Statistics Canada. At the request of various parties in Quebec[4] the survey was over sampled in view of obtaining a census of all manufacturing establishments employing more than 20 people. Overall response was obtained from 73% of such establishments, i.e. 3456 observations. Of these, 3158 are used in this study, the 298 omitted observations being in the logging and forestry industries, primary sectors that are excluded from this

[4] The organisations that participated in financing the manufacturing census are as follows: Institut de la Statistique du Québec, Ministère du Développement économique, de l'Innovation et de l'Exportation du Québec, Industrie Canada (région du Québec), Conseil National de Recherche du Canada (région du Québec), Ministère des finances du Québec, Conseil de la Science et de la Technologie du Québec. The Innovation Studies Research Network and INRS research funds financed access to these data.

analysis. Statistics Canada has assigned a weight to each observation in order to ensure overall representativity. Access to these data is difficult, especially for researchers not based in Ottawa or Quebec City: thus, only a few selected variables are available for analysis, and considerable costs have been incurred to obtain this limited access. This research is therefore exploratory and is limited in the extent to which it can investigate intra-establishment innovation dynamics. A few basic control variables have nevertheless been introduced in order to proxy for establishment-level characteristics.

The key importance of this database is that each observation is geocoded at the six digit postal code level, of which there are about 50 000 in Quebec. Thus each observation has an almost unique spatial identifier. It is therefore possible to study in detail the spatial distribution of innovation.

Two types of innovation are studied, product innovation and process innovation. Each of these is subdivided into innovations new to the firm, and major innovations new to the firm's market (for products) or new to Quebec (for process)[5]. Each of these four types of innovation is coded as a binary variable, and it is the spatial variation of this variable that is explored by way of logistic regression.

The basic model is as follows:

$$Inno_i = f\,(C_i, d_{ic}, R_i) + ,_i \qquad (1)$$

where

$Inno_i$ = innovation between 2002 and 2004 in establishment i (binary variable – the logistic regressions models the log of the odds ratio)

C_i = establishment characteristics, 3 variables.
- Exp_i = % of *within* province sales
- Sec_i = dummy variables for 18 three digit NAICS sectors
- $Size_i$ = dummy variable for size (less/more than 150 employees)

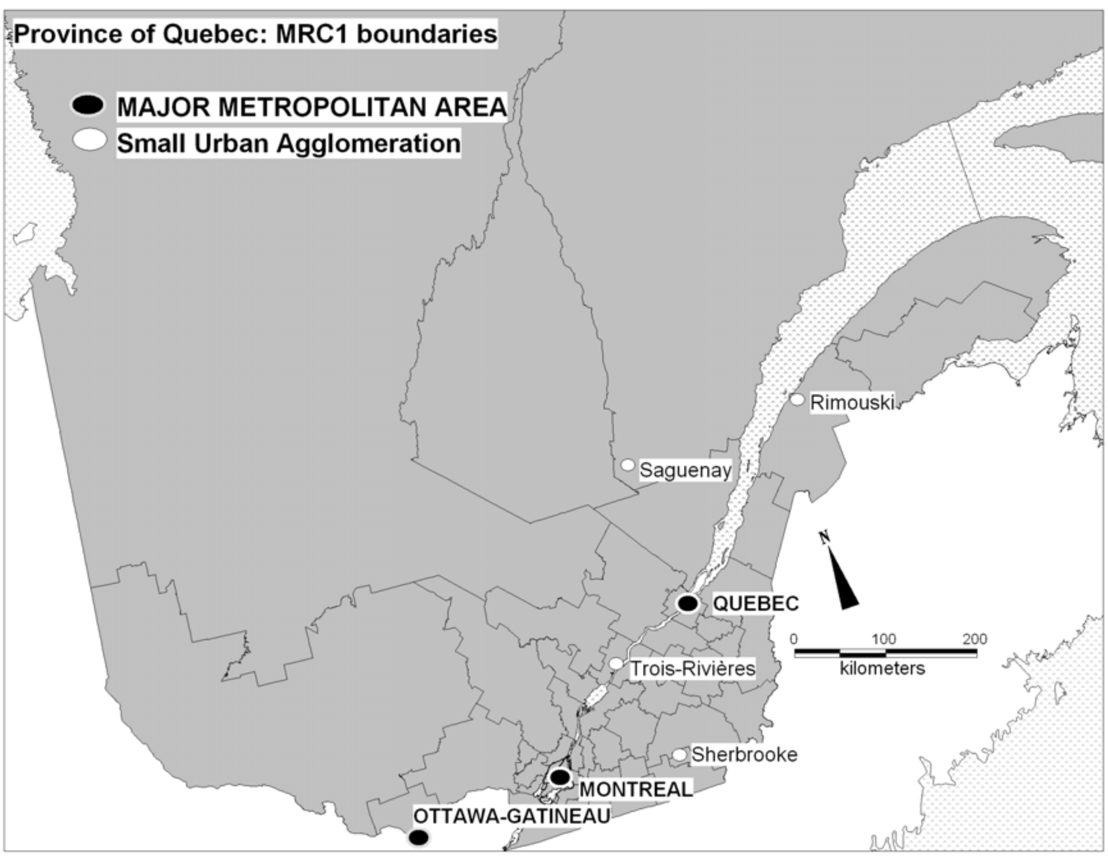
d_{ix} = distance of establishment from closest urban centres, 4 variables.
- $\log(d_{im})$ = log of distance to closest major metropolitan area (over 600 000 people). $\log(d_{im})^2$ is also tested in the models.
- $\log(d_{is})$ = log of distance to closest minor urban agglomeration (between 50 000 and 150 000 people). $\log(d_{is})^2$ is also tested in the models.

[5] see appendix 2a for the wording of innovation questions.

R_i = series of dummy variables for 50 regions of Quebec. $R_i = 1$ if the establishment is in the region.

The d_{ix} variables are Euclidian distances. Since distances are measured towards a few large cities, straight-line distance is a good approximation of network distance (APPARICIO et al, 2003). Furthermore, in Quebec, outside of rush-hour in Montreal, distance and time are interchangeable since traffic tends to flow at an average speed of 90 to100km an hour. The major metropolitan areas are Montreal (3.5 million people), Ottawa-Gatineau (1.1 million) and Québec (600 000). The minor urban agglomerations, each with at least one university and a variety of research institutes, are Saguenay (144 000), Sherbrooke (147 000), Trois-Rivières (126 000) and Rimouski (50 000) (see Figure 1). Only agglomerations of over 50 000 people and beyond 100km from a major metropolitan area have been included as minor agglomerations.

Figure 1: Province of Quebec. MRC1 boundaries and urban areas



The regional classification (R_i) is based upon Municipalités Régionaux de Comtés (MRCs), equivalent to counties in Quebec. In remote areas some MRCs have been merged in order to ensure a minimum of 20 observations per region, leading to a modified spatial classification that we refer to as MRC1 (see figure 1). It can be objected that this way of dividing space is arbitrary, and does not deal with the questions identified above relating to the proper scale and limits of regions[6]. This objection is quite valid, and can be leveled at all most other studies: in Europe, it is often NUTS2 or even NUTS1 regions that are used (MAGGIONI ET AL, 2007; TAPPEINER et al, 2008), and in a number of other studies it is metropolitan regions (SIMMIE, 2001), another arbitrary subdivision of space. In effect, researchers are usually constrained to take whatever spatial subdivisions are available and assess their pertinence. To the extent that MRCs correspond to the scale at which regional policies are usually implemented in Quebec, and to the extent that labour markets do not usually extend across MRC boundaries (except in the immediate vicinity of Montreal), the MRC level is a good scale at which to test the hypothesis that there exist local dynamics or factors leading to higher levels of innovation in local establishments.

The analytical strategy adopted is as follows. To begin the variation of innovation with distance from an urban area is explored. The 'best' spatial models are identified by removing distance variables one by one until the remaining distance variables all attain at least 90% significance level. The a local effect is then introduced: if the discrete regional classification enters the model significantly whilst eliminating the significance of the distance variables, then it is concluded that there are (unspecified) regional factors of innovation: such a result would be compatible with the neo-regionalist approach, further study being necessary to identify which particular innovation dynamics cause regional differences in innovation. If, however, the regional effect is not significant but some or all distance variables remain significant, then it is concluded that there are no local innovation dynamics within Quebec but, rather, innovative firms are sensitive to access to a few nodal points: this will demonstrate that the spatial-analytic approach provides new insight into the geography of innovation. Of course, it is possible that no spatial or

[6] The results are very similar with a lower level of aggregation (67 spatial units instead of 50). However, the minimum number of observations by region is then only 10, and the results with 50 regions are more robust.

regional effects will be significant, in which case an argument can be made that, notwithstanding evidence from elsewhere, there appear to be no spatial innovation dynamics within Quebec.

6. Results

6.1 Context

Quebec is a province in eastern Canada. It comprises about 7.5 million inhabitants, roughly the same population as Sweden (9 million) and Denmark (5.5 million) – and hence an entity within which it is reasonable to expect that local innovation dynamics occur. DOLOREUX (2004), for instance, conducts a case study of two such regions: Beauce (100km to the south of Quebec) and Ottawa-Gatineau (the Gatineau part of which is in Quebec). Furthermore, Quebec covers a large area: although the majority of its population and economy is distributed between Montreal and Quebec, particularly in Montreal, a number of smaller and more remote centres such as Rimouski and Saguenay play an important local and regional role (POLÈSE & SHEARMUR, 2002).

Only limited descriptive information is available concerning the 2005 Innovation census since the statistical agencies prefer to limit the diffusion of tabulations in order to avoid the circulation of contradictory numbers. The spatial coverage of the data are uneven (Figure 2), but representative of the spatial distribution of manufacturing in Quebec (Polèse & Shearmur, 2002). Since the survey is a census, the sectoral coverage is also representative of Quebec's. The 18 sectors that serve as control groupings are listed in appendix 1: there are at least 100 observations in each sector, and some of the smaller sectors have been aggregated (as indicated in the appendix) in order to ensure this.

Figure 3, compiled at the regional level (there are 17 regions in Quebec and almost 50 MRC1s) reveals that there is some variation between regions in innovation rates. However, this variation may be due to differences in sectoral composition, in firm size or in other firm attributes, and is not necessarily attributable to the regions themselves.

Figure 2: Spatial coverage of data: number of establishments

MRC1 spatial units (regions)	# of MRC1s	approximate number of observations per MRC1
Montreal	1	n > 700
MRC1s directly surrounding Montreal	8	75 > n > 200
Quebec	1	n > 250
Rimouski, Saguenay, Trois-Rivières, Sherbrooke	4	50 > n > 100
Other MRC1s	36	20 > n > 75
Quebec (all MRC1s)	**50**	**3158**

Figure 3: Innovation in Quebec regions

REGION	Innovators	Product	Process	Product and Process	Product only	Process only
Quebec	68.7	50.1	55.2	36.6	13.6	18.6
Bas-St-Laurent	63.6	36.9	53.5	26.8	10.1	26.7
Saguenay-Lac-St-Jean	68.7	40.8	59.2	31.4	9.4	27.9
Capitale Nationale	71.4	53.9	53.3	35.8	18.1	17.5
Mauricie	64.9	36.8	54.9	26.8	10.0	28.0
Estrie	70.4	46.2	61.0	36.8	9.4	24.2
Montréal	68.4	53.0	52.5	37.1	15.9	15.4
Outaouias	67.6	49.3	65.2	46.8	2.4*	18.4
Abitibi-Témiscamingue	65.7	47.0	45.4	26.8	20.2	18.7
Cote-Nord et Nord	60.3	32.9	52.7	25.3	7.6*	27.4
Gaspésie-et-Iles	43.1	32.5	25.2	14.7	17.9	10.5*
Chaudières-Appalaches	70.3	48.3	56.6	34.5	13.7	22.0
Laval	66.2	46.3	52.7	32.7	13.6	19.9
Lanaudière	68.3	49.7	58.6	39.9	9.7	18.6
Laurentides	68.1	54.5	55.2	41.6	12.9	13.5
Montérégie	71.5	54.6	58.4	41.6	13.0	16.8
Centre-du-Québec	68.1	47.1	55.9	34.9	12.2	20.9

note: table adapted from ISQ (2008). Each number represents the percentage of establishments that respond positively to the innovation question (see appendix 2). Numbers followed by a '*' have been imputed by the author and are subject to measurement error.

6.2 Innovation and Space

There is prima facie evidence that product and process innovation varies in a continuous fashion across space in Quebec. Indeed, after controlling for certain establishment level characteristics (sector, propensity to export and establishment size – all of which are highly significant with respect to the propensity to innovate), the results in Figure 4 show that in all cases the propensity to innovate varies with distance to urban centres. Two general patterns emerge. For establishment-level product and process innovations, and for major process innovations, the propensity to innovate first rises with distance from a metropolitan area, then decreases. For major product innovation there is a uniform decrease in the propensity to innovate as distance rises from a major metropolitan area. In general, smaller urban areas have no effect on the propensity to innovate except for firm-level process innovations: for this type of innovation the propensity to innovate rises as one approaches a smaller urban centre.

Similar regressions have been run on two different groups of establishments; those within 100km of a major metropolitan area, and those beyond[7]. For product innovation it is found that the propensity to innovate does not vary significantly over space within 100km of a metropolitan area, and there is a weak tendency for major product innovation to *increase* with distance from a minor urban area beyond the 100km limit. Thus the significance of the distance variables in the overall product models seems to be picking up differences in the propensity to innovate between more central and more peripheral establishments (although a simple dichotomous variable does not pick up these differences). When establishments within 100km of a metropolitan area are analysed, the effect of distance from a metropolitan on process innovations is broadly similar to that observed for all observations. For establishments beyond the 100km limit, neither distance from major nor a minor urban area has an effect on the propensity to innovate.

These results are in no way meant to imply that space plays a causal role in the innovation process. Rather, they suggest that, whatever the social and economic processes at play, they display a spatial pattern. This pattern should be noted by researchers and policymakers: for the former, this pattern calls for explanation. What are the causal factors of innovation that vary in this way across space? For the latter, it brings attention to the fact that regional policy that focuses on innovation may not be equally applicable or effective in all locations.

[7] These results are not shown here but are available upon request.

Figure 4: Best models with distance variables only

		DF	Product				Process			
			new to firm		new to market		new to firm		new to market	
		DF	Chi2	Coeff	Chi2	Coeff	Chi2	Coeff	Chi2	Coeff
C_i	% exports	1	50.8***	-0.007	42.8***	-0.007	22.7***	-0.005	29.0***	-0.007
	Size (large=1)	1	10.2***	-0.12	8.3***	-0.11	21.8***	-0.18	9.5***	-0.15
	NAICS 3	16	186***		158***		89.9***		73.6***	
D_{ix}	log10(d_metro)	1	5.6**	0.56			14.4***	0.90	9.9***	1.21
	log10(d_metro)2	1	9.3***	-0.24	11.6***	-0.08	45.4***	-0.31	9.9***	-0.40
	log10(d_micro)	1					6.1**	-0.23		
	log10(d_micro)2	1								
R_i	MRC1	49								
	Pseudo R2		0.119		0.104		0.066		0.068	
	-2 Log Likelihood	Nul	5956		5580		5912		3854	
		Mod.	5619		5296		5732		3698	
	H & L test (chi2)		5.91		2.72		8.13		7.51	
	n		3158		3158		3158		3158	
	weight		4297		4297		4297		4296.64	
	weight=1		2153		1517		2366		710.71	

notes: Chi2 = Wald Chi2; Coeff = regression coefficient; Nul = nul model; Mod.= Full Model; pseudo R2 = maximum adjusted pseudo R2; H&L test = Hosmer and Lemeshow goodness of fit test. For all chi2 tests (Wald Chi2 and H&L), significance levels are as follows: *** = .99; ** = .95; * = .90.

Figure 5: Best models with distance and regional dummies

		DF	Product				Process			
			new to firm		new to market		new to firm		new to market	
		DF	Chi2	Coeff	Chi2	Coeff	Chi2	Coeff	Chi2	Coeff
C_i	% exports	1	51.3***	-0.007	43.0***	-0.007	22.5***	-0.005	32.4***	-0.008
	Size (large=1)	1	9.8***	-0.124	8.4***	-0.116	22.3***	-0.185	10.1***	-0.155
	NAICS 3	16	184***		156***		86.7***		74.7***	
D_{ix}	log10(d_metro)	1	0.94	0.29			4.34**	0.62	4.87**	1.06
	log10(d_metro)2	1	0.97	-0.14	2.08	-0.12	2.06	-0.21	3.20*	-0.38
	log10(d_micro)	1					0.02	0.03		
	log10(d_micro)2	1								
R_i	MRC1	49	65.0*		74.1**		48.7		47.5	
	Pseudo R2		0.119		0.104		0.066		0.0682	
	-2 Log Likelihood	Nul	5956		5580		5912		3854	
		Mod.	5550		5217		5682		3636	
	H & L test (chi2)		6.14		4.80		4.52		7.51	
	n		3158		3158		3158		3158	
	weight		4297		4297		4297		4297	
	weight=1		2153		1517		2366		711	

Notes: see Figure 4

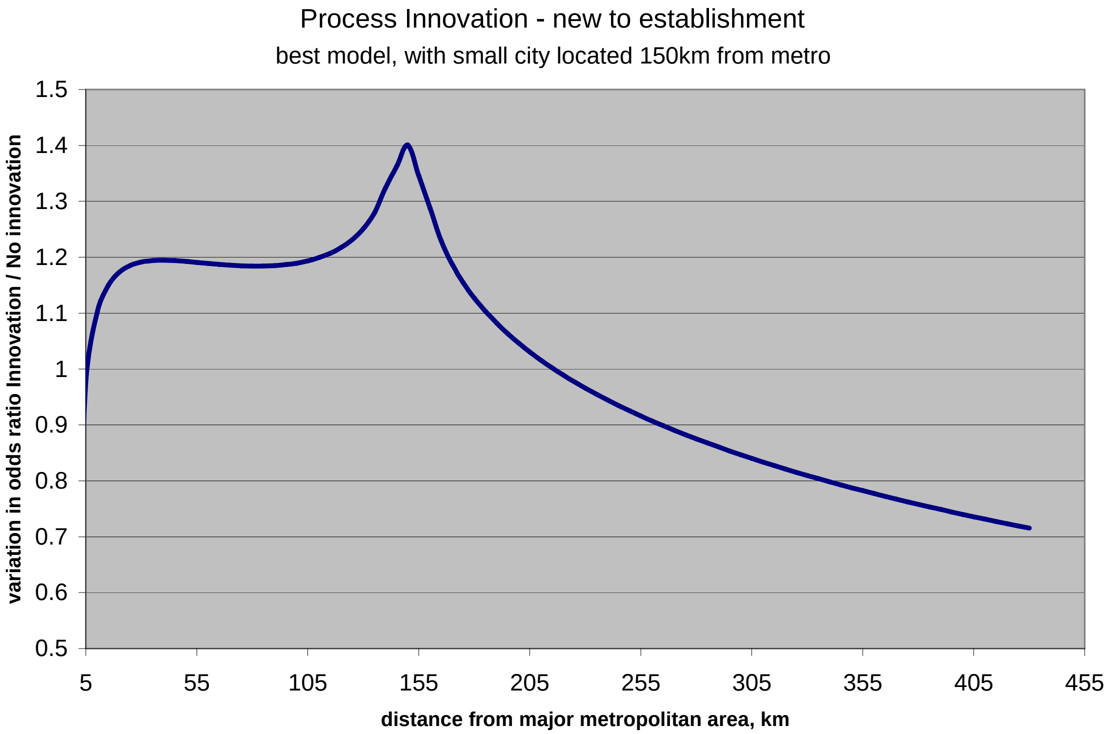
These results, whilst suggestive, do not undermine the neo-regionalist approach to the geography of innovation: as MAGGIONI et al (2007) point out, it may be that the spatial patterns observed reflect the regional distribution of innovation input factors. If this is the case, explanatory models would need to understand *why* inputs are distributed in such a way, but no new information will be obtained regarding the innovation process itself. Only if we can establish that the spatial patterns observed do not merely reflect the underlying regional distribution of input factors (be they institutions, clusters, local networks, local culture, knowledge workers…) can our results be construed as corroboration for the spatial-analytic understanding of innovation and space.

It is of course to be expected that the introduction of regional dummies will weaken the effect of distance in the models since the fine spatial divisions (see Figure 1) in effect summarise part of the distance information. It is therefore remarkable that the regional effect does not override the distance variables in the two process models (Figure 5). Indeed, for process innovation there is no evidence that local context plays any role whatsoever. To the extent that there is a connection between geography and process innovation in Quebec, it can better be understood by considering that the innovative potential of geographic points depends upon their location relative to urban centres. This is compatible with the spatial-analytic conceptualization of space.

However, this view of space is not the only relevant one. Following the same reasoning, it is the neo-regionalist view of space that seems to best fit the geography of product innovation. For this type of innovation, observed spatial patterns disappear after controlling for local effects, which enter the model in a significant fashion. This is similar TO MAGGIONI et al's (2007) and TAPPEINER et al's (2008) results, who find that the spatial-autocorrelation of knowledge spillovers disappears when the regional distribution of inputs is introduced.

Given that there is no discernible local effect for process innovation, it is the 'best' distance model in table 3 – without any regional variables - that will be considered. Figures 6 and 7 illustrate the variation of the odds ratio for process innovation with distance from urban areas. It should be noted that the absolute values in these figures have no significance, since no account is taken of the control variables or of the intercept: only the *variation* across space (distance) of the propensity to innovate can be interpreted.

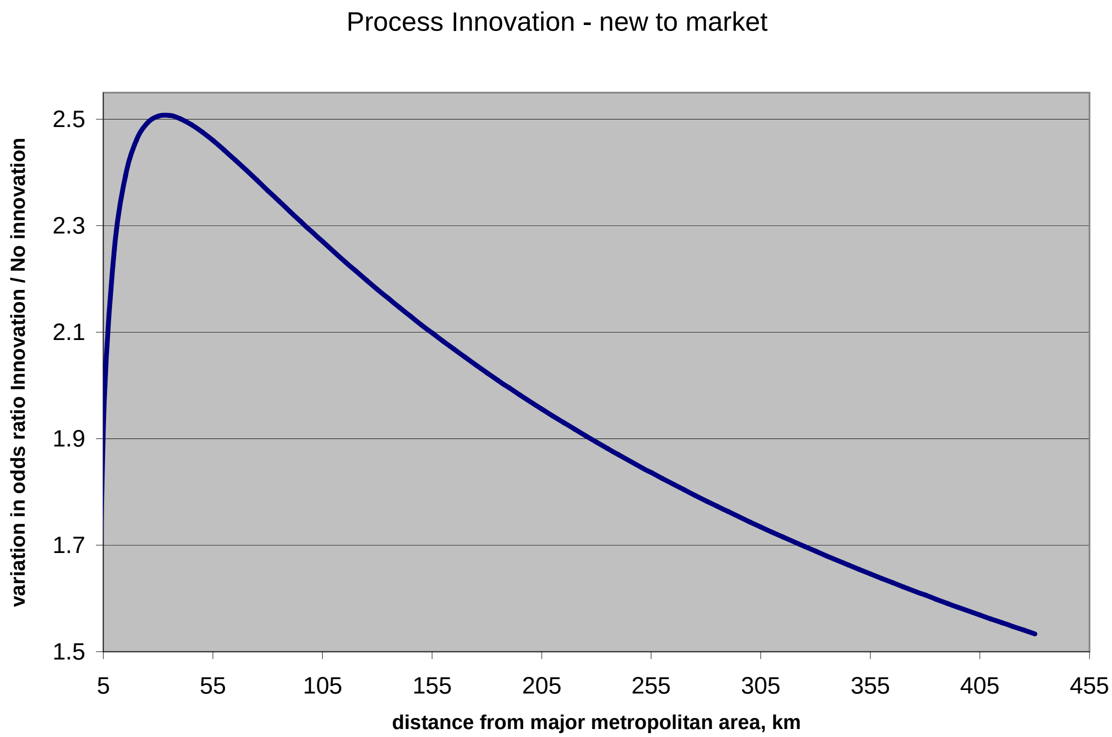
Figure 6: Process innovation and distance from large / small urban areas



note: the four small cities are between 120 and 220km from a major metropolitan area (figure 1). In this simulation, the effect of a small city located 150km from a major metropolitan area is shown.

The probability that a manufacturing establishment will introduce a major process innovation is a suburban phenomenon. Establishments at the heart of a major metropolitan area tend to innovate less than those located about 20 to 50km away. Major process innovation then decreases with distance from the metropolitan area. If it is accepted that process innovation is more often driven by imitative behavior, and that it relies on information about new process technologies, then this pattern suggests that information about processes new to the Quebec market is more easily available to establishments closer to large metropolitan areas. However, at some point – around 20 to 50km from the core of metropolitan areas – increasing proximity to metropolitan sources of information (or, indeed, to other input factors available in large cities) – ceases to be important. The decrease in propensity to innovate as one approaches the centre of metropolitan areas may be due to the existence there of a large number of manufacturers making more routine products for their metropolitan client base. Since we are analyzing the odds ratio, an increase in non-innovators will decrease the ratio.

Figure 7: Major process innovation and distance from large urban areas



If processes new to the establishment are analysed, a similar pattern is observed, but with an important difference (figure 7): the propensity to introduce a process new to the firm peaks towards the centre of small (50 000 to 150 000 inhabitants) urban areas. There is maybe more opportunity for imitative behavior in these smaller cities. In addition, bearing in mind the small local markets, there is maybe more incentive in these small cities to enhance productivity in order to be competitive and in order to overcome transport and communication costs which, for material objects, face-to-face contacts, and the maintenance of social and other networks, are higher in these smaller cities. It may also be the case that establishments in these cities are less specialized than the ones in and around metropolitan areas and that innovation (due to a reluctance to turn down business opportunities) is a necessary survival strategy in these smaller markets.

Product innovation, as we have seen, is more probable in certain local contexts than others. The local contexts in which product innovation is more probable are those where a higher proportion of the workforce possesses a trades certificate (Figure 8). The economy in these ‘product innovative’ localities tends to specialize in manufacturing (high manufacturing location quotients), *and* the manufacturing base itself is specialized (high specialization in particular manufacturing industries)[8]. This suggests the existence of localization (Marshall-Arrow-Romer) externalities leading to local innovation.

Figure 8: Correlation between regional product innovation and selected variables

	Product Innovation	
Type of innovation	Minor	Major
Salaries (average work income in 2000, full time work)	-0.12	-0.10
Income growth, 2000 to 2005	-0.13	-0.17
Employment growth, 2000 to 2005	0.06	0.06
% 25 to 64 year old with trades certificate	0.26 *	0.29 **
Log of total employment (measure of size of local economy)	-0.19	-0.35 **
Diversity index whole economy (64 sectors)	0.21	0.09
Diversity index *within* manufacturing (21 sectors)	0.35 **	0.25 *
Manufacturing location quotient	0.33 **	0.39 ***

Notes: this table presents correlations between the logistic regression coefficients for each of the 50 individual MRC1 regions (R_i coefficients, figure 5) and selected variables derived from the 2001 and 2006 censuses. The formulas for the diversity index and location quotient are given in appendix 2.

7. Conclusion

7.1 Main results

There is currently considerable debate over the nature, and indeed the existence, of a link between firm-level innovation and space. There is a long tradition of research, predominantly based on case-studies, that shows that in particular cases local institutional or cultural factors can be conducive to innovation. Other approaches have shown that, in particular cases, the presence of knowledge workers, of high levels of knowledge spillovers, or of competition and cooperation between firms can also lead to innovation. These approaches, strongly influenced by the reinvigorated regional geographies of the 1980s and 1990s, have in common the way in which the region is conceptualized, i.e. as a geographic space which has certain attributes that it does not share with others. These attributes – whatever their nature – are what leads establishments in certain regions to innovate more than others.

[8] see appendix 2b for the definition of location quotients and specialisation.

This neo-regionalist idea of space has been questioned from within this research tradition as it has become apparent that establishments also draw on the environment beyond their region. Without fundamentally altering the way in which space and geography are perceived, these questions have led to the idea that regions are connected with others either in a reticular (BATHELT et al, 2004) or in a hierarchical (FREEL, 2003; DOLOREUX, 2004; TIERLINK & SPITHOVEN, 2008) manner.

A small number of researchers have begun to suggest an alternative way of conceptualizing space. For McCANN (2007) and ANDERSSON & KARLSSON (2004) the space within which firms innovate is not a space of (more or less) well defined regions, but a space of accessibility and potential. Each point in space provides establishments with a series of opportunities. Locations that provide the best combination of opportunities (whether or not these opportunities are in the establishment's locality or not) will tend to encourage innovation more than others. These opportunities may well be opportunities of access to social networks, research institutions, competitors, collaborators, workforce, infrastructure etc… It is not the factors or processes of innovation that are being questioned in this paper, but rather the way in which these factors can be accessed from different points in space[9].

In this paper these two ways of conceptualizing the link between innovation and space have been empirically tested using a census of manufacturing establishments in Quebec. It is found that for process innovation, it is distance from core urban areas (and thus, distance from the opportunities and costs that can be found there) that is a stronger determinant of innovative behavior than the region where a firm is located. This confirms that, for process innovation in Quebec, it is the spatial analytic, rather than the neo-regionalist, approach that should prevail.

However, for product innovation, the opposite is found. Space as a continuum appears to play a role, but this role disappears when regional controls are inserted in the model. Whatever the processes or factors that lead to the observed spatial patterns they

[9] The distance decay of knowledge spillovers in the context of patents has also been studied, and this is a specific example of the general argument about accessibility to factors (knowledge being one of them) that are inputs in the innovation process.

correspond to a regional sub-division of Quebec. This confirms the relevance of the neo-regionalist approach.

7.2 Discussion

Confirmation that the neo-regionalist approach is valid is not surprising: indeed, much of the current literature on innovation and geography simply assumes this approach (ASHEIM & GERTLER, 2006). Of more importance is the demonstration that the spatial-analytic approach can provide new insights relating to the interaction between innovation and space. For certain types of innovation it is not *local* context, but *access* to resources, that is important. Access is a spatial concept: except for information available by electronic means, most other inputs to innovation have a geographic dimension: face-to-face contacts, access to knowledge intensive business services, entry points to global pipelines, delivery of products – all these are easier from some locations and more difficult from others. Indeed, TORRE's (2008) temporary contacts can be more plentiful and less costly if one is situated in some locations (e.g. within reach of an international airport) than in others (e.g. in northern Quebec – see map 1). In the same way, even if one is well integrated into social networks, and even if one benefits from organizational and cultural proximity (BOSCHMA, 2005), these proximities need to be exercised, used and maintained. Whilst much of this can be done at a distance, and therefore gives the illusion of a-spatiality, such long-distance proximities also require temporary – but regular – meetings (MARVIN & GRAHAM, 1996). The *maintenance* of proximity over time requires access to resources, and it is the need for such access that could explain the type of pattern identified in this paper for process innovation.

This implies that it is not only intangible resources such as governance, networks and knowledge that are required as inputs for innovation. In order to maintain the necessary proximities, *physical infrastructure and basic services* (such as air transport, highway maintenance, hotels etc…) are required. It is no coincidence that many – if not most – functioning innovation systems are in or near major metropolitan areas (CREVOISIER & CAMAGNI, 2001). Local face-to-face contact and knowledge spill-overs are only part of the story, and maybe a small part at that (BRITTON, 2003). It is the access that such locations provide (and that smaller urban areas also seem to provide in some circumstances) to a wide variety of innovation inputs *both local and more distant*, and the ease with which different types of proximity can be maintained from this type of location, that make metropolitan areas key organizers of spatial patterns of innovation. Merely seeking to correlate a metropolitan center's (or any other finite region's) attributes with local innovation activity – as neo-regionalists do - can only tell part of the story: in this paper we have shown that economic focal points can act as organizers of innovation activity across space well beyond their borders.

Many questions remain unanswered in this exploratory paper. Although similar results have been found when analyzing innovation in business services in Quebec (SHEARMUR & DOLOREUX, 2008), the type of pattern identified in this paper needs to be verified in other contexts. Whilst Euclidian distance is an acceptable approximation for accessibility in Quebec and at the scale we analyze, it is clear that better accessibility measures – ones that measure time along transport networks, and that combine road and air transport, would improve the model, particularly in areas with a more dense urban fabric, with more physical barriers, or if a larger spatial scale is analyzed. Also, we have only measured the effect of accessibility to urban areas: if detailed spatial data are available for a variety of key inputs to innovation then more complete accessibility measures can be calculated based upon weighted potential measures (ANDERSSON & KARLSSON, 2004).

At a more theoretical level we have suggested that the spatial-analytic approach to innovation studies raises new questions regarding the determinants of innovation, particularly questions related to infrastructure, to transport services, and to the underlying question of how proximities – whatever their nature (BOSCHMA, 2005; TORRE, 2008) - can be maintained over time. Even though most types of proximity can be a-spatial, they are nevertheless facilitated by physical accessibility to the entry points of global pipelines (and, more prosaically, to transport infrastructure and services): such a hypothesis needs to me more fully fleshed out and explored. The principal contribution of this paper is to provide empirical evidence that neo-regionalism is not the only way to approach the question of innovation and space.

References

ANDERSSON, M. and C.KARLSSON (2004) The Role of accessibility for the Performance of Regional Innovation Systems, in KARLSSON, C., P.FLENSBURG and S-A.HORTE (Eds), *Knowledge Spillovers and Knowledge Management*, Cheltenham: Edward Elgar, pp283-310

APPARICIO, P., R.SHEARMUR, M.BROCHU and G.DUSSAULT (2003) The measure of distance in a social science policy context: Advantages and costs of using network distances in 8 Canadian metropolitan areas, *Journal Geographic Information and Decision Analysis*, 7.2, pp105-131

ASHEIM, B., and M.GERTLER (2006) The Geography of Innovation: Regional Innovation Systems, in FAGERBERG, J., D.MOWERT and R.NELSON (Eds), *The Oxford Handbook of Innovation*, Oxford: Oxford University Press, pp291-317

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, pp31-56

BOSCHMA, R. (2005) Proximity and Innovation: A Critical Assessment, *Regional Studies,* 39.1, pp61-74

BRESCHI, S., and D.LISSONI (2001) Localised Knowledge Spillovers vs. Innovative Milieux: Knowledge 'tacitness' Reconsidered, *Papers in Regional Science*, 80, pp255-273

BRITTON., J. (2003) Network Structure of an Industrial Cluster: Electronics in Toronto, *Environment and Planning A*, 35.6, pp983-1006

CAMAGNI, R. P. (1995) The concept of *innovative milieu* and its relevance for public policies in European lagging regions, *Papers in Regional Science*, 74, pp317–340

CASTELLS, M. (1996) *The Rise of the Network Society*, Oxford: Blackwell

CHRISTALLER, W. (1966) *Die Central Places in Southern Germany*. New York: Prentice Hall (first published in German in 1933)

COOKE, P., M.GOMEZ URANGA and G.ETXEBARRIA (1997) Regional innovation systems: Institutional and organisational dimensions, *Research Policy*, 26.4-5, pp475-491

COOKE, P., M.HEIDENREICH and H-J. BRACZYK (Eds) (2004) *Regional Systems of Innovation: The Role of Governance in a Globalized World*, London: Routledge

CREVOISIER, O. and R.CAMAGNI (2001) *Les milieux urbains : innovation, systèmes de production et ancrage*, Neuchâtel : EDES

DEN HERTOG, P. (2000) Knowledge Intensive Business Services as Co-Producers of Innovation, *International Journal of Innovation Management*, 4.4, pp491-528

DICKEN, P. and P.LLOYD (1990) *Location in Space: Theoretical Perspectives in Economic Geography*, London: Harper Collins

DOLOREUX, D. (2004) Regional Innovation Systems in Canada: A Comparative Survey, *Regional Studies*, 38.5, pp481-494

DOLOREUX, D. and S.PARTO (2005) Regional Innovation Systems: Current Discourse and Unresolved Issues, *Technology and Society*, 27, pp33-153

EDQUIST, C. (1997) *Systems of Innovation: Technologies, Institutions and Organisations*, London: Pinter

FLORIDA, R. (1995) Toward the learning region, *Futures*, 27, pp527-536

FOTHERINGHAM, S., C.BRUNDSON and M.CHARLTON (2000) *Quantitative Geography: Perspectives on Spatial Data Analysis*, London: Sage

FREEMAN, C. (1995) The 'National System of Innovation' in historical perspective , Cambridge Journal of Political Economy, 19.1, pp5-24

FREEl, M. (2003) Sectoral Patterns of Small Firm Innovation, Networking and Proximity, *Research Policy*, 32, pp751-770

GERTLER, M. (2003) Tacit knowledge and the economic geography of context, or The undefinable tacitness of being (there)**,** *Journal of Economic Geography*, 3, pp75-99

GREUNZ, L. (2004) Interregional Knowledge Spillovers in Europe, in KARLSSON, C., P.FLENSBURG and S-A.HORTE (eds), *Knowledge Spillovers and Knowledge Management*, Cheltenham: Edward Elgar, pp110-142

ISQ (2008) *Science Technologie et Innovation en Bref: l'Innovation dans les Régions administratives du Québec*, Québec : Gouvernement du Québec, Institut de la Statistique du Québec

JAFFE, A. (1989) Real Effects of Academic Research, *American Economic Review*, 79, pp957-970

LIVINGSTONE, D. (1992) *The Geographical Tradition: Episodes in the History of a Contested Enterprise*, Oxford: Blackwell

LUNDVALL, B-A (1992) *National systems of innovation: Towards a Theory of Innovation and Interactivre Learning,* London: Frances Pinter

MAGGIONI, M., M.NOSVELLI and T. ERIKA UBERTI (2007) Space versus Networks in the Geography of Innovation: A European Analysis, *Papers in Regional Science*, 86.3, pp471-493

MAILLAT D., M.QUÉVIT, and L.SENN (Eds) (1993) *Réseaux d'innovation et milieux innovateurs: un pari pour le dévloppement régional*, GREMI/EDES, Neuchâtel

MALECKI, E. (1997) *Technology and Economic Development: The Dynamics of Local, Regional and National Competitiveness*, London: Addison Wesley Longman

MARKUSEN, A. (1999) Fuzzy Concepts. Scanty Evidence, Policy Distance: The Case for Rigour and Policy relevance in Critical Regional Studies, *Regional Studies*, 33.9, pp869-884

MARVIN, S. and S.GRAHAM (1996) *Telecommunications and the City*, *Electronic Spaces, Urban Places*, London: Routledge

MARSHALL, A. (1890) *Principles of Economics: an Introductory Volume*, accessed on-line at http://www.marx.org/reference/subject/economics/marshall/index.htm on 16/10/08

MASKELL, P. (1999) Globalisation and Industrial Competitiveness: The Process and Consequence of Ubiquitification, in MALECKI, E. and P.OINAS (eds), *Making Connections*, Aldershot: Aldergate, pp35-59

MASKELL, P., and MALMBERG (1999) Localised learning and Industrial competitiveness, *Cambridge Journal of Economics*, 23, pp167-186

MASSEY, D. (1995) *Spatial divisions of labor: Social structures and the geography of production* 2nd edition, New York: Routledge

MASSEY, D. (2005) *For Space*, London: Sage

McCANN, P. (2007) Sketching out a model of innovation, Face-to-face interaction and economic geography, *Spatial Economic Analysis*, 2.2, pp117-134

MORGAN, K. (1997) The Learning Region: Institutions, Innovation and Regional Renewal, *Regional Studies*, 31.5, pp491-503

MORGAN. K. (2004) The Exaggerated Death of Geography: Learning, Proximity and Territorial Innovation Systems, *Journal of Economic Geography*, 4, pp3-21

MOULAERT, F. and F.SEKIA (2003) Territorial Innovation Models: A Critical survey, *Regional Studies*, 37.3, pp289-302

POLÈSE, M. and R.SHEARMUR (2002) The *Periphery in the Knowledge Economy*, Montreal and Moncton: INRS and ICRDR, http://www.ucs.inrs.ca/default.asp?p=res , consulted on 16/10/2008

PHELPS, N., and T.OZAWA (2003) Contrasts in agglomeration: proto-industrial, industrial and post-industrial forms compared, *Progress in Human Geography*, 27.5, pp583-604

PORTER. M. (2003) The Economic Performance of Regions, *Regional Studies,* 37.6-7, pp549-578

PIORE, M and C.SABEL (1984) *The Second Industrial Divide*, New York: Basic Books

PRED. A. (1973) *Urban Growth and the Circulation of Information, 1970-1840,* Cambridge, MA: Harvard University Press

ROSENFELD, S. (1997) Bringing Business Clusters into the Mainstream of Economic Development, *European Planning Studies*, 5.1, pp1-23

ROTHWELL, R. (1992) Successful industrial innovation: critical factors for the 1990s, *R&D Management*, 22.3, pp221-240

SCHUMPETER, J. (1934) *The Theory of Economic Development*. Cambridge: Harvard University Press

SCOTT, A. and M.STORPER (Eds) (1985) *Production, Work and Territory: the Geographical Anatomy of Industrial Capitalism*, Boston: Allen Unwin

SIMMIE, J. (Ed), (2001) *Innovative Cities*, Oxford: Taylor and Francis

SHEARMUR, R., P.APPARICIO, P.LIZION and M.POLÈSE (2007) Space, Time and Local Employment Growth : An Application of Spatial Regression Analysis, *Growth and Change*, 38.4, pp697-722

SHEARMUR, R., and M.POLÈSE (2007) Do Local Factors Explain Local Employment Growth?: Evidence from Canada, 1971-2001, *Regional Studies*, 45.4, pp453-471

SHEARMUR, R. and D.DOLOREUX (2008) *Local context and innovation in Quebec: Can regional KIBS-based innovation systems be identified*?, Toronto: ISRN working paper, at http://www.utoronto.ca/isrn/publications/NatMeeting/NatSlides/Nat08/Shearmur_Doloreux%2008_Context_Innovation_Que.pdf, accessed on 17/10/08

STORPER, M. (1995) The Resurgence of Regional Economies Ten Years Later: The Region as a Nexus for Untraded Interdependencies, *European Urban and Regional Studies*, 2.3: pp191-221

TAPPEINER, G., C.HAUSER and J.WALDE (2008) Regional Knowledge Spillovers: Fact or Artifact?, *Research Policy*, 37: pp861-874

TÖDTLING, F. and M.TRIPPL (2005) One Size Fits All? Towards a Differentiated Regional Innovation Policy Approach, *Research Policy*, 34: pp1203-1219

TORRE, A. (2008) On the Role Played by Temporary Geographical Proximity in Knowledge Transmission, *Regional Studies,* 42.6: pp869-889

TORRE, A. and A.RALLET (2005) Proximity and Localization, *Regional Studies,* 39.1, pp47-59

TIERLINCK, P., and A.SPITHOVEN (2008) The Spatial Organization of Innovation: Open Innovation, External Knowledge Relations and Urban Structure, *Regional Studies,* 42.5, pp689-704

VELTZ, P. (1996) *Mondialisation, villes et territoires : une économie d'archipel*, Paris : Presses Universitaires de France

WEBER, A. (1929) *Theory of the Location of Industries*, Chicago: The University of Chicago Press (first published in German in 1909)

Appendix 1: Economic sectors (Sec_i)

311+312=Food manufacturing and beverage and tobacco product manufacturing
313+314=Textile mills and textile product mills
315+316=Clothing manufacturing and leather and allied product manufacturing
321=Wood product manufacturing
322=Paper manufacturing
323=Printing and related support activities
324=Petroleum and coal products manufacturing
325=Chemical manufacturing
326=Plastics and rubber products manufacturing
327=Non-metallic mineral product manufacturing
331=Primary metal manufacturing
332=Fabricated metal product manufacturing
333=Machinery manufacturing
334=Computer and electronic product manufacturing
335=Electrical equipment, appliance and component manufacturing
336=Transportation equipment manufacturing
337=Furniture and related product manufacturing
339=Miscellaneous manufacturing

Note: the numbers correspond to NAICS three digit codes

Appendix 2a

Innovation questions:

1- Product innovation new to firm (yes to a or b):

A PRODUCT INNOVATION is the market introduction of a new good or service or a significantly improved good or service. The innovation (new or improved) must be new to your plant. Exclude the simple resale of new goods purchased from other plants and changes of a solely aesthetic nature.

During the three years, 2002 to 2004, did your plant introduce

a. New or significantly improved goods

b, New or significantly improved services

2- Major product innovation:

Did your plant introduce ANY new or significantly improved products (goods or services) onto your market before your competitors during the three years, 2002 to 2004?

3- Process innovation new to firm (yes to a, b or c):

A PROCESS INNOVATION is the implementation of a new or significantly improved production process, distribution method, or support activity for your goods or services. The innovation (new or improved) must be new to your plant.

During the three years, 2002 to 2004, did your plant introduce

a. New or significantly improved methods of manufacturing or producing goods or services b. New or significantly improved logistics, delivery or distribution methods for your inputs, goods or services

c. New or significantly improved supporting activities for your processes, such as maintenance systems or operations for purchasing, accounting, or computing .

4- Major process innovation (yes to a, b or c):

During the three years, 2002 to 2004, were ANY of your new or significantly improved processes

a- a first in your province / territory;

b- a first in Canada?;

c- a first in North America;

d- a world first?

Appendix 2b

Diversity Index

Each of the 50 MRC1 is more or less diversified. The index is used to assess the speciality or diversity of their economic structure. It measures the divergence of the MRC1's employment distribution from that of Quebec as a whole. It is as follows:

$$I_r = \ln\left(\frac{1}{n}\sqrt{\sum_{i=1 to n}(lq_i - 1)^2}\right)$$

where

I_r = diversity index for MRC1, r.

lq_i = location quotient of sector i in area r = $(e_i / e) / (E_i / E)$

e_i = employment in sector i in area r.
e = total employment in area r
E_i = employment in sector i in Quebec.
E = total employment in area Quebec

n = number of sectors (64 for whole economy; 21 for manufacturing)

For 'whole economy' diversity, E and e are total employment in all sectors. For 'manufacturing sector' diversity, E and e are total employment in the manufacturing sector.

If I_r tends - ∞, the profile resembles Quebec's, and the area is diverse.
If I_r tends to + ∞, the profile diverges from Quebec's, and area is specialized.