LIKE OIL AND WATER?
REGIONAL INNOVATION POLICY AND REGIONAL DEVELOPMENT POLICY

Richard Shearmur
Nicolas Bonnet

***Working paper*, n° 2010-2**

Centre - Urbanisation Culture Société

INRS
Université d'avant-garde

www.ucs.inrs.ca

LIKE OIL AND WATER?
REGIONAL INNOVATION POLICY AND REGIONAL DEVELOPMENT POLICY

Richard Shearmur
Nicolas Bonnet

Institut national de la recherche scientifique
Centre - Urbanisation Culture Société
Montreal

March 2010

Richard Shearmur
Richard.shearmur@ucs.inrs.ca

Nicolas Bonnet
Nicolas.bonnet@ucs.inrs.ca

Centre - Urbanisation Culture Société
Institut national de la recherche scientifique
385, Sherbrooke Street East
Montreal (Quebec) H2X 1E3

Phone : (514) 499-4000
Fax : (514) 499-4065

www.ucs.inrs.ca

Résumé
La plupart des recherches récentes qui se penchent sur l'innovation et les régions prend comme point de départ les districts Marshalliens, qui ont au fil du temps été augmentés par des concepts tels les *clusters*, les systèmes régionaux d'innovation et les régions apprenantes. L'idée de base est que certaines régions dynamiques suscitent de l'innovation. Beaucoup d'organisations qui se préoccupent du développement territorial en déduisent – de manière fallacieuse – que des politiques d'innovation locale entraîneront le développement économique local. Il n'y a cependant aucun lien nécessaire entre l'innovation et le développement locaux : en effet, il est tout a fait possible que de l'innovation dans la région A entraîne de la croissance (d'emplois et de revenus) dans la région B, en particulier si la région B dispose d'un meilleur potentiel d'exploitation des innovations. Dans cet article je développe en premier lieu cet argument, pour ensuite effectuer une analyse empirique de données canadiennes. En me servant de données pour 203 bassins d'emploi urbains (des données de recensement et des données de demandes de brevet), j'explore le lien entre l'intensité locale des demandes (qui est utilisée ici comme un indicateur d'activités innovantes) et la croissance locale d'emploi et de revenu (indicateurs de développement local). Les résultats démontrent qu'il n'existe presque aucun lien entre l'innovation locale et le développement local, et que le développement local est étroitement relié à l'accessibilité aux marchés, à la structure industrielle locale et à des facteurs régionaux dépassant la localité.

Mots clés :
Innovation; développement régional; développement local; territoire; politiques; Canada

---

Abstract
Much recent work on innovation and regions takes as a starting point Marshallian districts, which have been variously updated by concepts such as clusters, regional innovation systems and learning regions. The basic premise is that certain regional dynamics are conducive to innovation. By a leap of logic this work has inspired regional development agencies, which regularly implement local innovation policies that are intended to stimulate local economic development. However, there is no necessary connection between local innovativeness and local development: indeed, it is quite possible that innovation in region A leads to growth (of employment and income) in region B, particularly if region B is better suited to developing the economic potential of innovations. In this paper the conceptual underpinnings of this argument will be developed, and an exploratory empirical analysis undertaken. Using Canadian data (patent applications and census data for 203 urban labor market areas) this paper explores whether there is a connection between local applications (taken as an indicator of local innovative activity) and local employment and income growth (taken as measures of local development). The results show that there is virtually no connection between local innovation and local development, and that local development is closely connected with access to markets, local industrial structure and wider-scale regional factors.

Key Words:
Innovation; regional development; local development; territory; policy; Canada

Introduction

In this paper we ask the apparently straightforward question: does local innovation lead to local development? A cursory reading of recent policy documents (CEC, 2000; OECD, 2008; Technopolicy, 2008)[1] makes it clear that regions are striving to improve their innovation capacity in the belief that this will bring about local growth and development[2]. Academic work on regions and innovation has tended to focus on the local factors that bring about innovation, and often assumes that innovation will lead to local growth (Fratesi and Senn, 2009): although some researchers have recently begun to explore how firm-level innovation can feed though to regional growth (Frenken & Boschma, 2007; Fratesi & Senn, 2009), the question has not often been addressed, particularly from an empirical perspective (MacKinnon et al, 2002).

The argument developed in this paper is as follows: to the extent that policies are being implemented on the basis that successful innovation amongst local firms is a means of attaining positive local outcomes (such as job growth or wage increases), then such policies are based upon a logical fallacy, and upon the misapplication of the ideas behind endogenous growth theory. Firm-level innovation *may*, in certain contexts, lead to regional growth (Frenken & Boschma, 2007), and this paper will explore these contexts from the perspective of regional development. The purpose of this paper is therefore not to review in detail the literature on local innovation systems, innovative milieu or on growth theory (see Moulaert and Sekia, 2003; Cooke et al, 2004; Ray, 1998). Rather, after rapidly investigating why the belief that local innovation leads to local growth is so prevalent, we will discuss various ways in which innovation in an establishment (or in a local industry) feeds through, or fails to feed through, to the local economy.

The idea that innovation can lead to local development will be placed within a broader discussion of local development factors and of the highly problematic idea that regions can be treated as autonomous objects of analysis with internal (endogenous) development dynamics (Hudson, 2007). Although local growth is often accompanied by local innovation (Fratesi & Senn, 2009; Folloni, 2009; Frenken & Boschma, 2007), there is no necessary connection between local firm-level innovation and local growth: innovation in local firms can just as easily lead to local decline, and local growth may be caused by a variety of local and non-local factors. Since many factors affect local growth, local innovation dynamics, especially in smaller and more remote regions, may be largely unconnected with regional outcomes.

---

[1] Typical statements are : 'Innovation is seen by both national and regional levels as one of the keys to improving the productivity of the region and contributing to closing the growth gap (OECD, 2008)', and : 'Over the past few years, modern regions have recognized the need to develop regional innovation strategies to succeed in our competitive world' (Technopolicy, 2008)

[2] In economic policy terms, development is usually synonymous with growth, and this connection will be assumed. However, development without growth is possible (Polèse & Shearmur, 2006; Hudson, 2007) though politically unpalatable.

The implications of this argument for regional development policies will then be discussed. An exploratory empirical analysis of employment and income growth across Canadian cities provides some corroboration for the idea that local development is not closely connected with local innovativeness, and that other factors, such as local diversity, accessibility to markets and industrial structure capture the principal driving forces behind the development of regions. It is only in the very largest of regions (such as metropolitan areas), that there may be some connection between local innovation and growth, although this is not evident in Canada.

AN OVERVIEW OF THE CONNECTION BETWEEN INNOVATION, GROWTH AND REGIONS

Innovation – understood as technological change that leads to greater productivity and/or to better quality products – is a key driver of economic growth. This is hardly a novel insight: Toynbee (1884/1962) clearly understood this in the 19th century, Schumpeter (1936) and Mumford (1934/1962) in the early 20th century and Lewis (1955) in the immediate post-war years. Contemporaneously with Lewis (1955), some of the historical and empirical arguments developed by these authors were formalized by Solow (1956) in mathematical form. Orthodox theory, as well as historic and cultural evidence, henceforth recognized that the growth of an economy or of a (relatively closed) civilization was attributable not only to quantity (of labour, of capital) but also quality. As Toynbee, Schumpeter, Mumford and Lewis all made clear, in a manner that foreshadows the evolutionary economics put forward by Nelson & Winter (1982), growth was also dependent on cultural and institutional factors.

From the 1980s onwards these ideas gained a new saliency in western economies because the rapid growth and high profits of the post-war period (Fourastié, 1979) – propped up by war reconstruction efforts, growth in internal markets, and favorable terms of trade - had given way to industrial stagnation and vigorous competition from developing nations (Allen et al, 1981). The somewhat complacent view of economic growth that had taken root in governments during the post-war years gave way to an urgent need for economic regeneration. In this context innovation (Industry Canada, 2009) and knowledge (Courchenne, 1996; OECD, 1996) have become two of the key factors towards which western economies have turned in order to maintain competitiveness and sustain growth. These two factors, and a variety of ideas that are connected with them (such as networks, information, communication technology, entrepreneurship etc.), structure much of the current discourse on economic development and growth in industrialized nations.

Concurrently with the decline of manufacturing and the tertiartisation of the economy, and in keeping with wider disenchantment with top-down government interventions, the principles that govern regional development policy also underwent fundamental change during the 1980s and 1990s. From an explicitly redistributive stance (Brewis, 1969), whereby central governments attempted to redirect economic activities towards lagging regions by way of subsidies and other types of intervention, regional policies began increasingly to borrow from the ideas developed by Solow (1956) (and applied to national and city economies by Lucas (1988) and Romer (1990)), and increasingly focused upon endogenous development (Martin & Sunley, 1998). From this perspective, regions must build up the capacity to develop from within, stimulating their own local resources such as human capital, which in turn are thought to bring about regional development through internal interaction processes and positive externalities (Lucas, 1988).

It is in this context that researchers interested in innovation began to investigate the social underpinnings of firm-level innovation. Although firm-level innovation is principally dependent on the firm's own characteristics (Cohen & Levinthal, 1990), it is increasingly accepted that firms also draw upon their environment – i.e. upon firms, clients, institutions, local culture – and that this environment may influence the degree to which they innovate (Edquist, 1997; Lundvall, 1992). In other words, in some regions firms are more innovative than others *because of the region's characteristics* (Florida, 1995; Maillat et al, 1993; Cooke et al, 2004).

It is here that a leap of logic has occurred, which this paper will investigate in more detail. Indeed, on the basis that the economy (as a closed system) grows as a result of innovation, and on the further basis that firms draw upon their regional environment to innovate, regional policies are increasingly being implemented on the assumption that local innovation leads to local development (Werker, 2006). This reasoning is incorrect: the two first premises (1. that economic growth is partly attributable to innovation and 2. that regional dynamics can be conducive to innovation) only lead to this policy conclusion *if* endogenous growth theory is applicable to regions. Since regions are open systems, and since the smaller the region the more open it is, I will argue in this paper that there is no direct connection between innovation in local companies and local growth. Thus, although regional innovation policy might be of global relevance, ensuring that global levels of economic growth are as high as possible through the best use of all resources (including territorial ones), there is no reason to believe that the development benefits of innovation will occur in the territories or regions where innovation takes place.

Recently Frenken & Boschma (2007) have explored this question from the perspective of evolutionary economics. They make the crucial distinction between firms (which they further decompose into routines) and regions. For them it is the routine (within a firm) which is the key driver behind economic geographic outcomes, and it is the accumulation of firm-level decisions regarding the location of particular routines and of spin-offs that explains regional-level outcomes. A key part of their argument as it relates to the connection between firm-level innovation and regional development is that '...most spinoffs locate near their parent firm (Egeln et al., 2004), most new divisions are created inside existing plants and most employees change jobs within the same labour market area' (p638). Thus, although their model does not assume that local innovation leads to local growth, they do not problematise the connection between regional innovation and regional growth in their theoretical paper: rather, they state that it is usually so based upon previous studies.

In our view, the connection between local innovation and local growth is not straightforward. Of course, across the economy as a whole, the majority of spinoffs probably do locate as Frenken & Boschma (2007) suggest, because the majority of firms are located in or close to large cities. In these large cities (that benefit from Jacobs externalities), endogenous economic development –

i.e. cumulative innovation and growth processes - can occur (Lucas, 1988). However, the regions that suffer from local economic problems are precisely those that are unable to capture the spinoffs, those where such growth processes do not occur. For these regions, policies which encourage firm-level innovation may generate spinoffs that will be captured by other regions. Under this scenario, regional innovation policies, whilst contributing to overall economy-wide innovation, may precipitate local economic decline. Thus, regional *innovation* policies, as will be argued in this paper, must not be confused with regional *development* policies: a regional *innovation* policy will encourage local firms to establish new routines and spinoffs. A regional *development* policy will focus on ensuring that these new routines and spinoffs are captured locally. This distinction is rarely made in policy circles.

THE GEOGRAPHY OF INNOVATION-INDUCED GROWTH

As Fratesi & Senn (2009) make clear, local innovation can only lead to local development if firms are sufficiently locally embedded. Innovation itself, to the extent that it is dependent on local regional attributes (institutions, networks etc..), is also partly dependent on the degree and nature of local embeddeness. Thus, the nature of the local environment is both a causal factor in the innovation process and a causal factor in the extent to which the locality benefits from innovation.

To clarify the way in which the local environment contributes to innovation in local companies, and also to the regional impacts of innovation, Figure 1 illustrates these processes. Most research on innovation and regions has tended to focus upon the top half of figure 1: innovation in company A is understood as being an outcome of environmental and internal factors. Internal factors consist of the firm's human capital, its technical resources and its research and development capacities (Vega-Jurado et al, 2008). External factors are of three types: i) local environmental and institutional factors (Cooke et al, 2004; Morgan, 1997; Porter, 2003; Lundvall, 1992); ii) non-local factors of the same sort (Boschma, 2005; Torre, 2008; Lundvall, 2005) and iii) market contacts and feedback mechanisms (von Hippel, 1988). In all cases the effect of these external factors is meditated by the firm's own absorptive capacities (Cohen & Levinthal, 1990) – which are themselves closely related to the firm's internal resources.

Far less research has been conducted on the lower segment illustrated in Figure 1, that is on the regional impacts of innovation. This is partly due to the popularity of endogenous growth theory in the context of local development (Martin & Sunley, 1998). Indeed, as outlined above, it has become increasingly accepted both amongst economic geographers (Storper & Walker, 1989; Tickell et al, 2007) and policy makers that regions and localities develop endogenously: in other words, regions must rely on their own institutions, resources and capital (especially human) to develop, and local development policy must focus on the development of these local capacities (Bryant, 2002). It is not the purpose of this paper to critique endogenous growth theory: however, it is important to point out that the theory, and most of its empirical verification, has been elaborated to '[account] for the observed pattern, across *countries* and across time, in levels and rates of growth in per capita income' (my italics, Lucas, 1988, p3).

The essential quality of countries, and indeed of large regions such as metropolitan areas to which the theory has also often been applied (Rauch, 1993; Acs, 2002), is their size and diversity. Notwithstanding the obvious fact that countries, and even more so metropolitan areas, are open to exchanges and flows with the rest of the world, the fact remains that these geographic entities are large enough to internalize many labour market and other processes: they are *partially closed* economic systems within which knowledge exchange, information flows and other externalities

can take effect. It is therefore reasonable to assume that local processes can generate local effects in this type of region, even if some of these effects are have consequences outside the locality.

As the localities to which local development ideas are applied become smaller, the theoretical basis upon which local development rests weakens and eventually disappears. As Cousineau & Vaillancourt (1987) demonstrate in Canada, for smaller regions the only effect of human capital investment is to provide qualified labour for the large metropolitan areas towards which qualified people migrate. It is the contention of this paper that this argument is equally valid when it comes to innovation: for smaller regions, local innovation does not necessarily lead to local growth. The degree to which a locality will benefit from local innovation in its firms is conditioned by its capacity to capture innovation spinoffs locally (Figure 1).

Thus, when the geographic impact of innovation in company A is considered (lower part of Figure 1), this impact is divided into local and non-local impact. The apportionment of local and non-local impacts will depend upon two factors: first, the company's internal strategy and organization will have an important effect. If, for instance, a company innovates and decides to close a (local) old plant in order to open a (non-local) new plant, then local impact will be negative (Massey, 1995). Second, and perhaps more importantly, the resources, services and markets *easily accessible* from the locality will come into play and will influence the firm's location decision. Indeed, firms in a particular locality can draw upon resources in other localities, and this is often overlooked in a context where local growth is thought to be endogenously derived. Thus, in a small locality, a firm may be able to expand if it has access to services, markets and labour in nearby communities: even though some of the spinoffs will occur elsewhere (for example the purchase of services), at least some can be captured locally (for example a new production or marketing facility). If the locality is isolated, innovation may stimulate the local economy into generating local resources, but in many cases it will lead the firm – an isolated actor with little independent influence over its context – to exploit its innovation elsewhere. Even though a region's development is an aggregation of firm-level decisions, these decisions are taken – at least in part - on the basis of regional characteristics, most notably availability of resources and access to markets. This feedback loop may be virtuous in some cases, as the literature on agglomeration economies and endogenous development attests, but can be negative in others, not necessarily because of the region's internal dynamics but because of exogenous (interaction between world markets and local industrial structure, for instance) or geographic (notably degree of isolation) factors.

A key factor that will determine whether or not local resources are available is size: the larger the local economy, the greater the chances that innovative firms will find the necessary local resources (human capital, technology etc...) to apply and develop their innovation, thereby ensuring that the innovation's consequences are captured internally to the locality; the greater the

likelihood, also, that it will find some local suppliers and services. However, size is not the only such factor: accessibility to markets, diversity, industrial structure, human capital and costs – to name but a small number of such factors - also play an important role. These factors are those that enable a firm to build the capacity and the market necessary for bringing its innovation to the production phase, the phase which is the only one that, if captured locally, will lead to employment or to income growth. Stated another way, if a firm innovates but needs to move elsewhere to find markets, clients or labour necessary to expand production, then this innovation will have, at best, no local economic impact.

We have so far assumed that innovation leads to employment growth within the firm, which it often does (Lachenmaier & Rottman, 2006) even if the location of this new employment cannot be ascertained: however, innovation does not *always* lead to employment increase. Particularly in industries towards the end of their product life-cycle, process innovations that lead to increased productivity often lead to employment loss. From an economy-wide perspective, despite the social problems that this can cause, this is an efficient process since it leads to the reallocation of resources towards more productive activities. If this process of creative destruction can take place within a region, then it will also lead to a more productive region, and to regional growth. However, the smaller the region, the less likely it is that the local economy can generate alternative activity when it is needed: thus, in a small region, labour saving process innovations can lead directly to job loss and regional decline.

It could be argued that the very institutional and environmental factors that contribute to the creation of local innovation systems also contribute to a locality's capacity to internalize the positive economic effects of innovation (Figure 1). This argument is only partially valid. Whilst it is true that a region's institutional context, the level of competition/collaboration between economic agents, and the degree to which innovation is welcomed locally will play an important part in determining if a locality is able to derive economic benefit from local innovation, these intangible dimensions can only come into play provided that the basic material and geographic factors are also present. If a locality can only generate innovation but cannot provide the material conditions necessary for production and marketing nor the alternative activities necessary for the creative destruction process to occur, then it will not derive economic benefit from its innovation[3].

[3] Romer (1993), though he emphasises the importance of knowledge, intangible factors and 'ideas' as drivers of economic development, does not neglect the more mundane material world, 'objects' : we would argue that appropriate geographical context is an 'object' necessary for development to take place.

All this may seem highly theoretical and largely irrelevant to real-life innovation scenarios. However, the following three examples illustrate that the conceptual framework just presented plays out in real cases[4]:

- company A, in a small city (about 20 000 people) in a remote part of Quebec (about 300km east of Quebec City) produces a line of innovative and sought after luxury kitchen cabinets. The owner wishes to continue living in this locality, but cannot expand due to lack of qualified labour. Innovation in his company has no effect upon local employment levels, since it is not a forgone conclusion that a more standard line of kitchen cabinets would not generate as many local jobs. At best innovation is serving to maintain employment.

- company B, in another small central city (about 25 000) similarly located to the previous one, provides engineering consultancy services. The consultancy developed there thanks to demand from the resource extraction industry, which had subsided. There is growing demand for its services from international clients, and the company was actively seeking to expand. A new office was opened in Montreal to cater to international markets and to ensure presence at international conferences and trade fairs. Innovation in this company in this city is leading to employment growth in Montreal – though again employment is maintained in the city.

- Alcan, a major aluminum producer with production facilities in Saguenay (a city of 150 000), has been introducing more efficient aluminium production techniques. Over the course of 1981 to 2006, employment in the aluminium industry in this city has declined from about 7800 to 4600, and total population in the city has declined from 157 000 to 149 000. Notwithstanding the high rate of innovation in the aluminium sector, because the city is not capable of re-integrating the excess labour into its workforce, there is out-migration. Innovation in Alcan in Saguenay is leading to employment decline in Saguenay (whilst wages for those employed remain high). Although Alcan is used as an example, this scenario is repeated across Canada as resource extraction industries and basic manufacturing industries in small or remote regions innovate: as local productivity increases, local employment falls (Polèse & Shearmur, 2006), though market share is often maintained or even increased.

These examples are quite specific: they all relate to small or isolated labour markets in Canada. This, however, is the point being made in this paper: the nature of the region is key to understanding whether or not innovation will have a positive effect, and Canada provides clear evidence of this. Innovation in and of itself is not sufficient to generate regional development. The region itself, irrespective of the innovation dynamics that occur within it, must be

[4] These examples were observed during field-work undertaken 10 years ago in the context of a study on peripheral regions. At the time innovation and regional development was not of prime concern. It is only over the course of later research that the relevance of these examples has become clear.

sufficiently large and must provide sufficient access to markets, labour and to alternative employment for local innovation dynamics to be conducive to local development.

OTHER FACTORS OF REGIONAL GROWTH

Even if local innovation and the underlying institutional and cultural dynamics that lead to innovation are connected with local development, they are not the only factors that can explain local growth. For any locality, two broad types of factor may lead to growth, endogenous ones and exogenous ones (Shearmur & Polèse, 2007). Endogenous growth theory, translated by policy makers into local development policies (Martin & Sunley, 1998), provides a framework for conceptualizing how factors specific to each locality (e.g. its endowment in human capital, its level of diversity, its institutional dynamics, its level of innovation…) can bring about local growth.

However, as pointed out by Shearmur & Polèse (2007), localities – even if they appear functionally autonomous (such as labour market areas) - are not closed systems. They are situated within wider geo-structural frameworks – which themselves reflect historical processes, wider-scale networks and global markets - that determine to a great extent their growth outcome. A number of such factors can be highlighted.

- If one assumes that the growth and decline of particular economic sectors is in large part determined by global production and technology cycles, associated with national and global fluctuations in demand, then a locality's industrial structure is an important and largely exogenous factor of growth or decline. Particularly in smaller more specialized regions, growth and decline are closely connected with industrial structure. This can be true even for larger regions. For instance, Toronto's dependence on the auto and financial industries has strongly influenced its growth outcomes over the last few years.

- Accessibility to outside markets and factors of production is another crucial determinant of local growth. A small city in proximity to a major metropolitan area will have a very different development trajectory from an identical city situated in a remote location (Phelps & Ozawa, 2003): it can 'borrow' some of the agglomeration economies from its neighbour, and benefit from major infrastructure such as airports. Couched in terms of innovation systems, Bathelt et al (2004) show that the physical accessibility of innovation systems to other innovation systems is an important factor in understanding innovation dynamics.

- Furthermore, since cities are bound together into urban systems at various scales, the behavior of the system as a whole (for instance of the regional context within which cities are integrated) will influence the behavior of its constituent parts: growth dynamics may feed through these regional systems independently from each cities' particular characteristics (Pred, 1977; Pred and Tornquist, 1973).

Given these arguments, which are principally drawn from classic location theory and quantitative economic geography of the 1960s and 1970s (Dicken & Lloyd, 1990), it is not a forgone conclusion that a city's particular factor endowment or institutional context will influence its development trajectory. Indeed, Shearmur & Polèse (2007) show that in Canada geo-structural factors have a stronger influence over development outcomes than local factors.

The empirical part of this paper is an exploratory analysis that seeks to investigate whether local growth is connected with local innovativeness across 203 Canadian labour markets, or whether it is connected to geo-structural or to other local factors.

DATA AND METHODOLOGY

The assessment of innovative capacity in localities across an entire nation is highly problematic. On the one hand, innovation comes in many different forms. Whilst innovation surveys (OECD, 2005) are capable of identifying a variety of these forms, the surveys rarely have enough coverage to provide detailed geographic information upon which to base a local innovation index. Patent data, which are often used to assess innovation, are a rather idiosyncratic indicator (Grilliches, 1990). First, they only reflect radical product innovations: they do not record incremental innovation, and very rarely record process innovation. Second, the cost and legal expertise needed to obtain and protect patents are such that many companies, particularly smaller ones, resort to alternative ways of protecting their know-how (such as secrecy). Third, at the other end of the spectrum, large companies may obtain patents indiscriminately, on minor changes or on ideas that they have no intent of exploiting, in order to prevent competitors from innovating (Anselin et al, 2002). Fourth, there is probably a spatial bias in patenting towards larger cities: the required legal expertise can be more easily found there and larger companies tend to have their headquarters there (often the address from which a patent is filed). The great advantage of patent data for geographic analysis, however, is that they are available and that they are geo-referenced.

In this study, the regional indicator of innovativeness is based upon patent *applications*, not upon actual patents, recorded in the OECD "regionalized patent register", REGPAT (MARAUT et al, 2008). Applications are chosen to ensure wide geographic coverage, and because we wish to measure a locality's general level of innovative activity (rather than successful patents specifically). The REGPAT data, gathered under the auspices of the Patent Cooperation Treaty (PCT) treaty[5], provides the postal code of the address of each inventor on an application.

The PCT system does not provide an international patent but just an application registry: only if the patent is granted will it then be enforced in each country where patent protection is sought, but the mere fact of registering under the PCT provides temporary protection until a decision is made. PCT applications therefore capture a wider spectrum of (possible) innovations than actual patent data. Their use has increased over the past 20 years (Khan et al, 2005; Van Zeebroecka et al, 2009). They have been used, for instance, to analyse the value of patents (Guellec et al, 2000), and to study inventors' distribution across the space (Miguélez et al, 2009).

[5] The PCT system is managed by World Intellectual Property Organization (WIPO). Among others, this agency of the United Nations carries out a patent harmonizing between member states with the International Patent Classification (IPC) and provides the exhaustive database of patents applications PCT.

For our purposes, local innovativeness is measured for each locality by the sum of inventors multiplied by applications for the years 1997 to 2005[6] (see appendix 1). Concretely, therefore, we can investigate the following question: does the innovation activity of a region's inventors, as measured by the number of times an inventor from the region is associated with a PCT application between 1997 and 2005, have any impact on regional growth?

In order to ascertain whether local innovation (P) has an independent effect on local growth, it is necessary to control for the local and geo-structural factors that can account for regional growth at a local and at a wider scale. Following Shearmur and Polèse (2007), the following factors are included as controls: industrial structure (I, dummy variables), region (R, dummy variables), industrial specialisation (Sp, index), local costs (W, proxied by local wage levels), local human capital (K, proxied by % of graduates), local market (M, proxied by population), accessibility to surrounding markets (M', population potential). The details of each variable are included in appendix 1. Local institutional and cultural factors cannot be integrated into such a model since they are not measurable across such a wide sample. However regional differences in these factors are accounted for by regional fixed effects. Local variation is not accounted for, unless one assumes that the innovativeness variable is – to some extent at least – an outcome of these local intangible effects.

Given these concepts and dimensions, the model that is tested is designed to assess whether local growth (measured by employment and wage growth) between 2001 and 2006 is significantly connected with local innovativeness after controlling for other possible growth factors. The model is as follows:

$$G=f(P, R, I, Sp, W, K, M, M')$$

Control variables are introduced as blocks (Sp, W, and K form one block, M and M' another, and R and I are each another block), then together. The model is tested using robust OLS regression: outliers are systematically removed if their leverage is high (Cooke's distance greater than 4/n). Each model is tested for multicollinearity amongst independent variables, and the significance levels of coefficients are adjusted for possible heteroskedasticity[7]. For each analysis a reduced model is presented: this model is derived from the full model (all variables included), to which a backwards stepwise selection process is applied: variables are retained if their significance level is 90% or higher.

[6] Prior to 1997 the REGPAT data are not reliable, and in any case innovative activity prior to 1997 is too far removed from our period of study. We do not wish to include applications made after the period of study, which is 2001-2006.

[7] Regressions are undertaken in SAS using PROC REG. A first regression is performed, and outliers removed. A second regression is performed on remaining observations. The ACOV option is used to obtain t values and significance levels that are corrected for heteroskedasticity. A list of outliers for each regression is available upon request.

The geographic localities that are studied are the 203 Canadian urban areas that have over 10 000 inhabitants in 2006. These comprise 144 census agglomerations and census metropolitan areas, defined by Statistics Canada as groups of municipalities that are linked by strong commuting ties and that surround a core municipality with at least 10 000 inhabitants (Statistics Canada, 2010). In other words, they are labour market areas. The remaining 59 urban areas are all the remaining municipalities which have over 10 000 people and that are not linked by strong commuting ties to other municipalities. These too can be considered as labour market areas. The fact that all 203 localities are labour market areas is important: indeed, were they not functional regions in at least this respect it would not be expected that local innovation could be internalised.

Geography has been explicitly introduced into the model by way of regional dummy variables, and by way of accessibility to surrounding markets. This approach is preferred to the use of formal spatial regressions because the geographic patterns are of specific interest in this study: rather than seeing spatial dependence as a bias, we acknowledge its presence and seek to explicitly introduce it. The residuals of each model are tested for spatial auto-correlation, which is virtually absent after explicit spatial structures are introduced.

RESULTS

There is little evidence that the intensity of local inventiveness is associated with either local employment (table 2) or wage (table 3) growth.

Despite a significant correlation between local employment growth and local innovation, which is not dependent on the region in which localities are found (table 2, A, B), this correlation disappears as soon as industrial structure (table 2, C) or local diversity (table 2, D) are introduced. Local employment growth is primarily affected by the region in which each locality is situated (table 2, B) and by industrial structure (table 2, C), which both lead to high adjusted r^2. Thus, even if local employment growth is weakly associated with local innovation, this link exists because certain economic sectors are associated with higher patent levels: it is not innovation itself but certain innovative industries that are conducive to regional growth, and this is commensurate with the idea that it is external demand for products in these sectors (rather than local innovativeness) that leads to local growth.

Access to markets (table 2, F) is another key determinant of local employment growth which is additional to local diversity and industrial structure. It should be noted that city size, the variable usually associated with local agglomeration economies, is *not* associated with local employment growth. Indeed, it is not the size of the city itself but the extent to which it can provide easy access to external markets that is associated with its growth performance. These conclusions hold whether central or peripheral cities are considered (Table 2, H and I).

Turning now to wage growth (table 3), this is primarily determined by region and by industrial structure. There is no evidence, even without controls, that local innovativeness feeds into local wage growth. Overall, therefore, these results tend to confirm that local innovativeness is not a determinant of local growth. This does not mean that innovation is not connected to growth across the economy as a whole, nor that there do not exist certain local circumstances in which connections between innovation and growth exist: the results show that the economic benefits of innovation are not captured in any systematic way by those localities from which innovation emanates.

However, the conclusions do not hold if central and peripheral regions are considered separately. Cities in proximity to Canada's major metropolitan areas show a weak tendency to benefit, in wage terms, from local innovativeness. This can be interpreted as evidence that their accessibility to markets enables local innovations to be exploited locally. The more innovative cities in peripheral regions actually see their wages decline: this is commensurate with the idea that innovation may lower the local demand for labour (or increase it elsewhere), thus putting relative downward pressure on wage growth (Figure 2).

The measure of innovation we have used is rather specific: patent applications usually emanate from sectors such as resource extraction, technical business services and particularly manufacturing. It is therefore possible that, even if local innovativeness has no growth impact on localities overall, it may have an impact on local growth within certain specific sectors.

Table 4 presents results for the reduced model (complete model to which backwards selection has been applied) for employment growth in eight sectors[8]. The local innovativeness variable is only associated with employment growth in manufacturing, and more specifically in basic manufacturing sectors. This is an interesting result for two reasons: on the one hand, because it is primarily firms in manufacturing sectors that apply for patents, this result lends validity to the innovativeness measure used in this paper. On the other hand it provides prima facie evidence that, within certain sectors, there is a systematic connection between local innovation and local growth, even if this does not feed through to the local economy as a whole.

The connection between local manufacturing employment growth and local innovativeness disappears if central and peripheral cities are analysed separately (table 5): the overall connection between manufacturing growth and local innovation therefore appears to be attributable to differences between central and peripheral regions. However, basic manufacturing grows faster in innovative central cities – lending further credibility to the idea that location in proximity to a major metropolitan area facilitates the local capture of innovation benefits.

This result is not replicated in other manufacturing sectors. Indeed, in high-tech manufacturing sectors the opposite result is found: it is only in peripheral areas that there exists a connection between local innovativeness and high-tech manufacturing growth. In short, and without pushing the interpretation of these results too far, there is no clear connection between local innovativeness and local employment growth – which is precisely as expected if the mechanisms illustrated in Figure 2 are at play. In some cases, and for some sectors, there appears to be a relationship, but not for others.

There exists one other connection between innovativeness and employment change, but this is a negative one for professional services (which include marketing, law and accountancy, Table 4). These professions grow faster in large cities which are not innovative. This suggests a geographic separation between innovativeness itself and the professions which protect (law) and which market it (marketing). Whilst results of this type of regression can only be suggestive, they corroborate the idea that the exploitation of innovation does not co-locate with innovation. These services, whose growth (partly) depends on industrial innovation as captured by patent applications, can locate in central places and extract value (and create jobs) from innovation

[8] We do not have data for wage levels on a sectoral basis.

occurring elsewhere (Shearmur & Doloreux, 2008). This provides an explanation for the lack of correlation between overall employment growth and local innovativeness: even if local innovation can indeed lead to local employment growth in the manufacturing sector, it can also lead to non-local employment growth. The net result of this is lack of overall connection between local innovativeness and local growth: it is only those localities which *both* generate innovation AND capture all (or most of) of their positive repercussions (in the innovative sectors *and* in the service and financial sectors) that will derive local benefits from innovation.

DISCUSSION AND CONCLUSION

Many current regional development policies assume that local development – usually understood as local employment or income growth – is a consequence of local innovation. They therefore place much emphasis on encouraging innovation in local firms. This approach is supported by various bodies of research which demonstrate that economic growth is dependent upon innovation (across the economy as a whole – Solow, 1956), that growth processes are often endogenous (to countries and to metropolitan regions. Lucas, 1988; Rauch, 1993; Acs, 2002), and that innovation tends to lead to employment growth in innovative firms (Werker, 2006). Furthermore, another body of research has established a connection between territorial dynamics and firm-level innovation (Moulaert & Sekia, 2003).

Whilst these influential studies and theories seem to justify the idea that local development can be encouraged by focussing on local innovation, this is a false inference for a variety of reasons. First, although the connection between growth and innovation has been established for the economy as a whole, it does not follow that each component of the economy will benefit equally from innovation: this is a distributional question, both across society and across space, which growth theory does not deal with. Second, although endogenous growth theory, as applied to local development, seems to support the idea that local dynamics – innovation in particular - are associated with local growth, this can only hold for localities that are sufficiently large and diversified to exploit their own innovations and capture, locally, the benefits[9]. Studies of large regions and metropolitan areas have to some extent revealed a connection between local innovation dynamics and local growth, but few studies have tested this connection across smaller and more isolated cities, communities where endogenous development is far more problematic. Third, even if innovative firms do create jobs and push wages higher, this does not necessarily occur locally: the internal decision making processes of firms are such that each innovation requires decisions to be taken regarding which routines to locate where (Franken & Boschma, 2007), and which external services to purchase where (Shearmur & Doloreux, 2008). It is only if both of these decisions tend to focus on the locality where the innovation occurs that the connection between firm-level innovation and employment will translate into local employment growth. Finally, even if there exist local dynamics and institutional contexts that encourage firm-level innovation, each firm must still make decisions about locating its own routines and purchasing external services once it has innovated.

In short, there is no reason to believe that there will be any systematic connection between local innovation and local growth, particularly in smaller and more isolated cities.

[9] A number of researchers are beginning to point out this problem as it relates to innovation, both by picking up contradictions in the literature (Werker, 2006) or by extrapolating from case studies (Doloreux & Melançon, 2009).

Our results show that, notwithstanding the fact that manufacturing employment (particularly in basic manufacturing) tends to grow faster in innovative localities, this does not translate into faster job growth in these localities. Indeed, some of the service sector jobs connected with obtaining patents and marketing innovation grow systematically faster in cites that are not innovative. In terms of wages, innovative cities benefit from faster growth if they are located in proximity to metropolitan areas, but actually suffer from significantly slower growth if they are located in a peripheral region.

These results are of an exploratory nature: they cover a limited period (2001-2006), and the measure of innovativeness is rather approximate. Furthermore it measures the presence and activity of local inventors, not of local firms. This limitation is, for the time being, inherent to the study of innovation across space. Constructing a systematic index of innovativeness that covers all cities in a given country (203 in Canada) almost necessarily requires the use of patent data, which we have associated with the location of each inventor in order to reduce the bias (towards certain cities) of using the location of the applicant firm. The limited time period covered could be extended if spatialized patent data going further back in time were available, and this would be an interesting way of extending the study: however, a five year time span is one that is commensurate with many policy time-frames, and identifying medium term effects is important in a policy context.

Despite these limitations, which invite further empirical investigation of the topic, the results underscore the theoretical arguments raised in this paper. They illustrate that there is no straightforward connection between innovation and growth across cities. Employment and wage growth can be very well explained (statistically speaking) by the models presented: both are primarily dependent on geo-structural factors such as region and accessibility, on industrial factors such as sectoral structure and degree of specialisation, and to a lesser extent upon human capital. In this context, local innovativeness has no influence on overall employment and wage growth. If specific sectors are looked at, and if cities are separated between those in proximity to a large metropolitan area and those that are not, then local innovativeness may, or may not, be connected with growth: this ambivalent relationship is what one would expect in the light of the fact that there is no necessary connection between local innovativeness and local growth.

There is some evidence to suggest that service sector jobs associated with innovation tend to grow in the least innovative cities, whereas jobs associated with innovative sectors themselves (i.e. manufacturing sectors) do tend to grow in innovative cities. There may therefore be a functional separation between innovation itself (and the new manufacturing jobs directly dependent on it) and its exploitation (jobs in marketing, sales and legal advice). Innovation in one place (and in one sector) may lead to employment growth in another place (and in another sector). This is far from the idea of local endogenous development, and much closer to the urban

systems theory developed in the 1970s (Pred, 1977; Pred & Tornquist, 1973) and subsequently largely abandoned.

Innovation is a worthwhile and necessary area of government policy, and nothing in this paper suggests otherwise. Furthermore, there are good reasons to believe that in some cases particular local configurations of culture, institutions and actors can lead to high levels of local innovation. However, this is not enough to establish that there exists a link between local innovation and local economic development in terms of employment or income growth. Questions of regional development rest on far more than innovation, and often rest upon factors outside the control of localities, regions or even national government. Only once this is acknowledged can regional development, as opposed to regional innovation, be truly addressed.

References

ACS, Z. 2002. *Innovation and the Growth of Cities*, Cheltenham (UK): Edward Elgar

ALLEN, R., A.BATI and J-C.BRAGARD. 1981. *The Shattered Dream : Employment in the Eighties*, London : Arrow

ANSELIN, L., A.VARGA and Z.ACS. 2002. Patents and Innovation Counts as Measures of Regional Production of New Knowledge, *Research Policy* 31, 1069–85

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

BOSCHMA, R. 2005. Proximity and Innovation: A Critical Assessment, *Regional Studies,* 39.1, 61-74

BREWIS, T. 1969. *Regional Economi Policies in Canada*, Toronto: MacMillan

BRYANT, C. 2002. Urban and Rural Interactions and Rural Community Renewal, in BOWLER, I., C.BRYANT and C.COCKLIN, *The Sustainability of Rural Systems*, Dordrecht: Kluwer

CEC. 2000. *Presidency Conclusions of the Lisbon European Council*, March 2000,

Brussels. Commission of the European Communities

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

COURCHENNE, T. (ed). 1996. *Policy framework for a Knowledge Economy*, Montreal-Kingston: McGill-Queen's University Press

COUSINEAU, J-M. and F.VAILLANCOURT. 1987. Investment in University Education, Regional Income Disparities and Regional Development, in COFFEY, W. and M.POLESE (eds), *Still Living Together: Recent Trends and Future Directions in Canadian Regional Development*, Montreal: Institute for Research on Public Policy

COHEN, W. and S.LEVINTHAL. 1990. Absorptive Capacity: a New Perspective on Learning and Innovation, *Administrative Science Quarterly*, 35.1, 128-152

CRISCUOLO, P. 2009. Inter-firm Reverse Technology Transfer: the Home Country Effect of R&D Internationalization, *Industrial and Corporate Change*, 18.5, 869–99

DICKEN, P. and P.LLOYD. 1990. *Location in Space*, New York : Harper Collins

DOLOREUX, D. and Y.MELANCON. 2009. Innovation-support Organizations in the Marine Science and Tecyhnology Industry: the Case of Quebec's Coastal Region in Canada, *Marine Policy*, 33, 90-100

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

FLORIDA, R. 1995. Toward the learning region, *Futures*, 27, 527-36

FOLLONI, G. 2009. A Model of Local Development, in FRATESI, U. and L.SENN, *Growth and Innovation of Competitive Regions : The Role of Internal and External Connections*, Berlin : Springer Verlag

FOURASTIÉ. J. 1979. *Les Trentes Glorieuses*, Paris : Hachette

FRATESI, U. and L.SENN. 2009. Regional Growth Connections and Economic Modelling : An Introduction, in Fratesi, U. and L.Senn, *Growth and Innovation of Competitive Regions : The Role of Internal and External Connections*, Berlin : Springer Verlag

FRENKEN, K. and R.BOSCHMA. 2007. A theoretical framework for evolutionary economic geography : industrial dynamics and urban growth as a branching process, *Journal of Economic Geography*, 7, 635-49

GRILICHES Z. 1990. Patent Statistics as Economic Indicators: a Survey, *Journal of Economic Literature,* 92, 630–53

GUELLEC, D. and B.VAN POTTELSBERGHE de la POTTERIE. 2000. Applications, Grants and the Value of Patent, *Economics Letters*, 69, 109–14

von HIPPEL, E. 1988. *The Sources of Innovation*, New York: Oxford University Press

HUDSON, R. 2007. Region and Place: Rethinking Regional Development in the Context of Global Environmental Change, *Progress in Human Geography*, 31.6, 827-836

INDUSTRY CANADA. 2009. *Business Plan 2009-2010*, Ottawa : Industry Canada, http://www.ic.gc.ca/eic/site/ic1.nsf/vwapj/IC_BusinessPlan200910-eng.pdf/$file/IC_BusinessPlan200910-eng.pdf (consulted on 18/09/09)

KHAN. M and H.DERNIS. 2005. Impact of Patent Cooperation Treaty Data on EPO patent Statistics and Improving the Timeliness of EPO Indicators, *OECD STI Working Paper 2*

LACHENMAIER, S. and H.ROTTMAN. 2006. *Employment Effects of Innovation at the Firm Level*, IFO working paper 27, Munich: Institute for Economic Research, University of Munich

LEWIS, A. 1955. *The Theory of Economic Growth*, London, George Allen Unwin

LUCAS, R. 1988. On the Mechanics of Economic Development, *Journal of Monetary Economics*, 22, 3-42

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

LUNDVALL, B-A. 2005. *National Innovation Systems -Analytical Concept and Development Tool,* Copenhagen : DRUID, (http://www.druid.dk/conferences/summer2005/papers/ds2005-603.pdf)

MACKINNON, D., A.CUMBERS and K.CHAPMAN. 2002. Learning, Innovation and Regional Development : a Critical Appraisal of Recent Debates, *Progress in Human Geography*, 26.3, 293-311

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

MARTIN, R. and P. SUNLEY. 1998. Slow Convergence? The New Endogenous Growth Theory and Regional Development, *Economic Geography*, 74.3, 201-227

MASSEY, D. 1995. *Spatial Divisions of Labor: Social Structures and the production of Geography*, New York: Routledge (2nd edition)

MIGUÉLEZ, E., R.MORENO and J.SURINACH. 2009. Inventors on the Move: Tracing Inventors' Mobility and its Spatial Distribution, *Research Institute of Applied Economics, Working Papers*, *16*

MORGAN, K. 1997. The Learning Region: Institutions, Innovation and Regional Renewal, *Regional Studies*, 31.5, 491-503

MOULAERT, F. and F.SEKIA. 2003. Territorial Innovation Models: A Critical Survey, *Regional Studies*, 37.3, 289-302

MUMFORD, L. 1934. *Technics and Civilzation*, New York, Harcourt Brace & World Inc

OECD. 1996. *The Knowledge-based Economy*, OCDE/GD(96)102, Paris : Organisation for Economic Cooperation and Development

OECD. 2005. *Oslo Manual (third edition)*, Paris: Organisation for Economic Cooperation and Development and Eurostat

OECD. 2008. *OECD Reviews of Regional Innovation : North of England, UK*, Policy Brief, October 2008, Paris : Organisation for Economic Cooperation and Development

PHELPS, N., and T.OZAWA. 2003. Contrasts in Agglomeration: Proto-industrial, Industrial and Post-industrial Forms Compared, *Progress in Human Geography*, 27.5, 583-604

POLÈSE, M. et R. SHEARMUR. 2006. Why Some Regions will Decline: A Canadian Case Study with Thoughts on Local Economic Development, *Papers in Regional Science*, 85.1, 23-46

PORTER. M. 2003. The Economic Performance of Regions, *Regional Studies,* 37.6-7, 549-78

PRED, A. 1977. *City-Systems in Advanced Economies*, London: Hutchinson

PRED, A. and G.TORNQUIST. 1973. *Systems of Cities and Information Flows*, Lund: Lund Studies in Geography

RAUCH, J. 1993. Productivity Gains from Geographic Concentration of Human Capital: Evidence from the Cities, *Journal of Urban Economics*, 34, 380-400

RAY, D. 1998. *Development Economics*, Princeton: Princeton University Press

ROMER, P. 1990. Endogenous Technological Change, *Journal of Political Economy*, 98.5, S71-102

ROMER, P. 1993. Idea Gaps and Object Gaps in Economic Development, *Journal of Monetary Economics*, 32, 543-73

SCHUMPETER, J. 1936. *The Theory of Economic Development*, Cambridge, Harvard University Press

SHEARMUR, R., et M.POLÈSE. 2007. Do Local Factors Explain Local Employment Growth?: Evidence from Canada, 1971-2001, *Regional Studies*, 45.4, 453-71

SHEARMUR, R. et D.DOLOREUX. 2008. Urban Hierarchy or Local Milieu? High-order Producer Service and (or) Knowledge-intensive Business Service Location in Canada, 1991-2001, *Professional Geographer*, 60.3, 333-55

SOLOW, R. 1956. « A contribution to the Theory of Economic Growth », *Quarterly Journal of Economics*, 70:65-94

STATISTICS CANADA. 2010. *Census Dictionary 2006,*Ottawa : Ministry of Industry, http://www12.statcan.gc.ca/census-recensement/2006/ref/dict/pdf/92-566-eng.pdf

STORPER, M. and R.WALKER. 1989. *The Capitalist Imperative: Territory, Technology and Industrial Growth*, New York: Basil Blackwell

TECNOPOLICY. 2008. *Implementing Regional Innovation Strategies*, Conference announcement

TICKELL, A., E.SHEPPARD, J.PECK and T.BARNES. 2007. Methods Matter: Transformations in Economic Geography, in TICKELL, A., E.SHEPPARD, J.PECK and T.BARNES (eds), *Politics and Practice in Economic Geography*, Los Angeles: Sage

TORRE, A. 2008. On the Role Played by Temporary Geographical Proximity in Knowledge Transmission, *Regional Studies,* 42.6, 869-89

TOYNBEE, A. 1884/1962. *The Industrial Revolution*, Boston, Beacon Press

VEGA-JURADO, J., A.GUTIERREZ-GRACIA, I.FERNANDEZ-DE-LUCIO, L.MANJARRES-HENRIQUEZ. 2008. The Effect of External and Internal Factors on Firm's Product Innovation, *Research Policy*, 37, 616-32

WERKER, C. 2006. *An Assessment of the Regional Innovation Policy by the European Union Based on Bibliometrical Analysis*, Papers on Economics and Evolution, Max Planck Institute of Economics

VAN ZEEBROECKA. N, B.VAN POTTELSBERGHE de la POTTERIE et D.GUELLEC. 2009. Claiming More: the Increased Voluminosity of Patent Applications and its Determinants, *Research Policy*, 38, 1006–20

Appendix 1: Variable definitions

P_a is the log of the number of inventors in city a weighted by the number of patent requests they have filed. Note that a single inventor can be recorded in a number of different cities if he/she moves between patent applications. However, each inventor-patent dyad will only be recorded once in each city, the city where the inventor lived when he/she filed the patent.

$$P_a = \ln \sum_{i}^{n} s_i p_s$$

where n = number of inventors in region a, s_i = inventor residing in region a, p_s = number of patent requests upon which s_i is listed as an inventor.

$localpat_a$ is a measure of the density of local inventors weighted by their patents, and is interpreted as an indicator of the inventiveness (in terms of patent applications) of the local population.

$$localpat_a = {}^{P_a}/_{lp01_a}$$

where $lp01_a$ = log of total population of region a.

$lpt01\_2_a$ is a measure of population potential for region a:

$$lpt01\_2_a = \ln\left(\sum_{i=1}^{413} p01_i / d_{ia}^2 \right)$$

where $i \neq a$, d_{ia} = Euclidian distance between i and a and $p01_i$ = population in region i. Note that this potential is calculated across all 413 regions, and not just the 203 cities.

$sp01_a$ is an industrial specialisation index:

$$sp01_a = \ln \sqrt{\frac{1}{23} \sum_{j=1}^{23} (lq_j - 1)^2}$$

where lq_j is the location quotient of sector j in region a. As $sp01a$ increases the industrial structure of region a is increasingly specialised relative to the Canadian economy as a whole.

Sector definitions

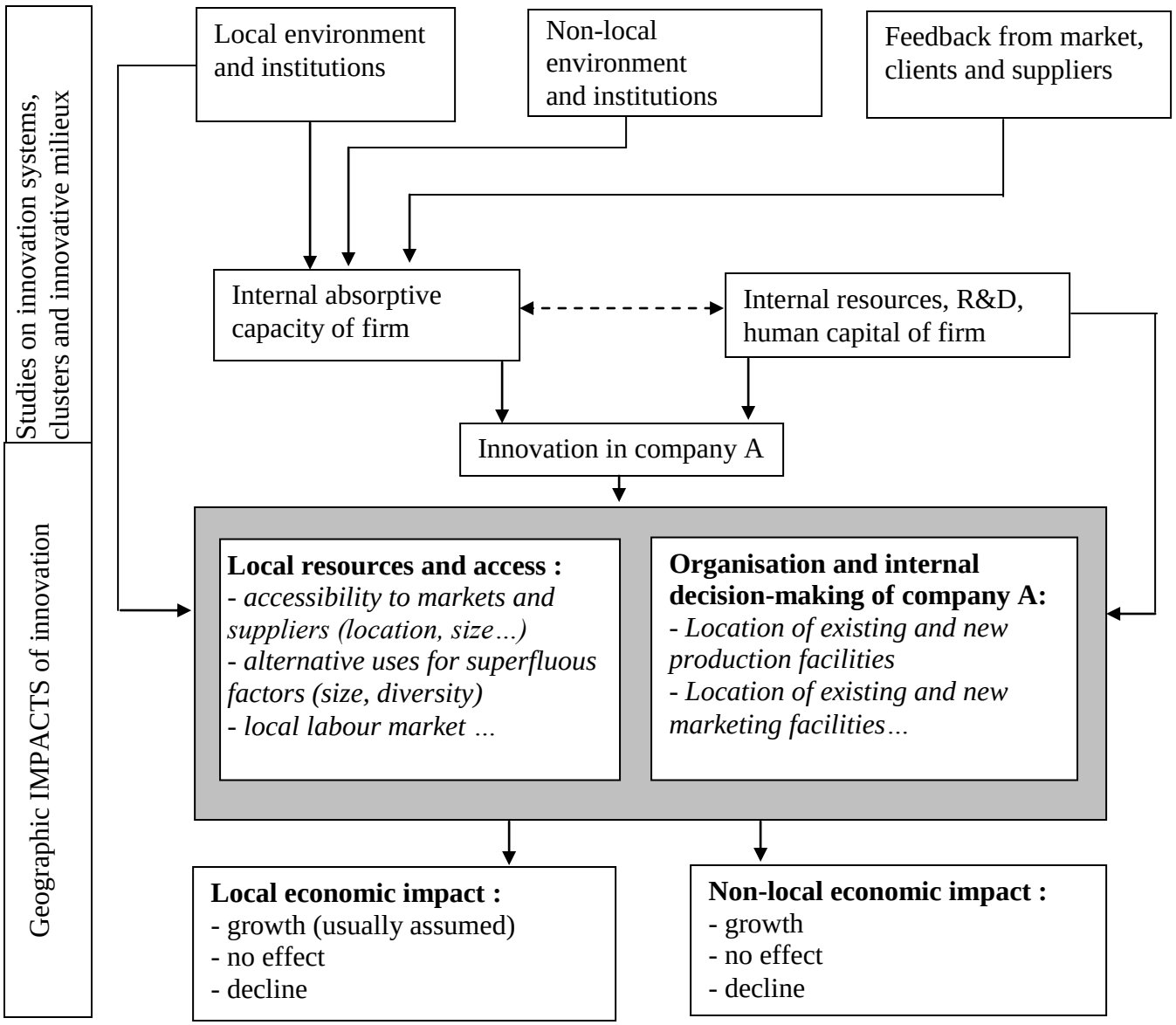
Basic manufacturing comprises first and second transformation industries such as pulp and paper, furniture, textiles, clothing, food processing ...

Medium manufacturing comprises industries such as transportation equipment, electrical equipment, chemicals, machines ...

High-tech manufacturing comprises aeronautics, pharmaceuticals, computers, telecommunications equipment and scientific and professional equipment.

High tech business services comprise engineering and architectural, management, and information technology consultants

Professional business services comprise marketing, legal and accounting services.



note : The vast majority of studies on regions and innovation examine the ways in which regions (i.e. their institutions, their productive milieux, local culture, competition and collaboration) play a causal role in the innovation behaviour of local companies, company 'A' in this figure. The IMPACT of innovation on regional economies is rarely studied because it is usually assumed that local innovation will be beneficial in terms of local development (i.e. in terms of job and wealth creation – though see Franken & Boschma, 2007, for a theoretical discussion). This assumption rests upon an ecological fallacy: it does not follow that because innovation leads to increased levels of global output (Solow, 1956) that local innovation leads to increased levels of local output. An increase in local output depends fundamentally on the locality's resources and on those that are accessible from it.

Figure 1 : Innovation and regional development

Table 1 : Variables used in regressions

Innovation data, 1996-2004		
*localpat**	continuous	indicator of inventiveness of local population (derived from number of patent requests filed from the region)
Industrial profiles in 2001		
CL8	dummy	Public admin, some high-order service and some leisure
CL7	dummy	Construction, retail, real estate, public services and leisure
CL6	dummy	Primary, construction, basic manuf., transport
CL14	dummy	Construction, medium and high-tech manuf., high-order services
CL11	dummy	Primary, basic manufacturing and public services (including education)
CL9	reference	Manufacturing (low and medium tech)
Regions		
Atlantic	dummy	Nova Scotia, New Brunswick, Prince Edward Island and Newfoundland
Ontario	dummy	Ontario
Prairies	dummy	Manitoba, Saskatchewan and Territories
Alberta	dummy	Alberta
British Columbia	dummy	British Columbia
Quebec	reference	Quebec
Local characteristics, 2001		
*sp01**	continuous	local specialisation index , across 23 sectors
lp01	continuous	log of local population
*lpt01_2**	continuous	population potential (excluding self-potential), based on squared distance
re01	continuous	local work income
pg_01	continuous	percentage of local population with university degree
Growth Variables, 2001-2006 (dependent variables)		
egth	continuous	% local employment growth
wic_gth	continuous	% growth in work income, defined as : (Total income derived from work) / (Total population declaring a work income)

* detailed definitions are provided in appendix 1

Table 2 : Employment growth in Canadian urban system, 2001-2006

	A	B	C	D	E	F	G	central H	peripheral I
Intercept	0.07***	0.06***	0.05***	-0.01	0.04	-0.14**	-0.11***	-0.18***	-0.12*
localpat	0.07**	0.07**	0.05	0.05	0.04	0.02			
Atlantic		0.00			-0.02	0.00		X	
Ontario		0.00			-0.028**	-0.03***	-0.03***	-0.02*	-0.03**
Prairies		0.00			-0.04**	-0.01		0.06*	-0.02*
Alberta		0.10***			0.05**	0.09***	0.09***	0.15***	0.05*
British Columbia		0.04**			-0.01	0.00		0.08***	
cl8			0.03**		0.04**	0.06***	0.04***	0.07***	
cl7			0.05***		0.05***	0.06***	0.05***	0.06***	0.04***
cl6			0.01		0.02	0.01			
cl11			0.00		0.00	0.03*	0.02		
cl14			0.02*		0.02	0.04**	0.03**	0.04**	
sp01				-0.03**	-0.02*	-0.02*	-0.02**		
re_01 (x10K)				0.00	0.00	0.01			
pg_01				0.00	-0.13	-0.22*			
lp01						0.00			0.01**
ltp01_2						0.02***	0.02***	0.04***	0.01*
adj r2	0.03**	0.26***	0.15***	0.05**	0.32***	0.46***	0.47***	0.55***	0.43***
n	197	191	194	193	190	188	188	102	83
max VIF	1.00	1.84	2.23	1.92	3.08	4.49	1.84	1.58	1.24
Moran's I	0.25**	0.12**	0.16**	0.19**	0.07	-0.01	-0.02	-0.05	0.00

notes : i) backwards selection for models G to H, condition : variable is kept if p(t=0) <= 0 .90.

ii) central cities : the 109 cities within approximately 100km of a major metropolitan area of over 500 000 people.
There are no central cities in Atlantic Canada.

iii) peripheral cities : the 94 cities beyond approximately 100km from a major metropolitan area.

iv) significance levels for p(t=0) : * <=0.950; ** <=0.990; ***<=0.999

v) Moran's I measures the spatial autocorrelation of residuals, based upon each city's 5 closest neighbours.

Table 3 : Wage growth in Canadian urban system, 2001-2006

								central	peripheral
	A	B	C	D	E	F	G	H	I
Intercept	0.13***	0.09***	0.10***	0.07	0.08	0.06	0.07***	0.15*	-0.11*
localpat	-0.02	0.02	-0.05	-0.07	-0.02	-0.04	-0.06	0.11	-0.19*
Atlantic		0.03*			0.01	0.02		X	
Ontario		0.02			0.01	0.01	0.01		
Prairies		0.09***			0.07***	0.08***	0.07***	0.08***	0.06***
Alberta		0.21***			0.18***	0.20***	0.20***	0.22***	0.11***
British Columbia		0.00			-0.02	-0.01			
cl8			0.08***		0.04	0.05*			0.06***
cl7			0.04**		0.03	0.03			0.02*
cl6			0.05***		0.04**	0.03**	0.03**		0.15***
cl11			0.01		0.00	0.01			
cl14			0.07***		0.03*	0.03*			
sp01				0.01	0.01	0.01			
re_01 (x10K)				0.02	0.00	0.00		-0.03	
pg_01				0.42**	0.23	0.22	0.44***	0.35**	
lp01						0.00		-0.01*	0.02**
ltp01_2						0.00		0.10	
adj r2	0.00	0.45***	0.10***	0.05*	0.48***	0.50***	0.50***	0.50***	0.71***
n	197	193	195	193	192	193	190	103	88
max VIF	1.00	1.74	2.15	1.71	3.59	4.38	1.84	4.07	3.37
Moran’s I	0.20**	-0.02	0.22**	0.20**	-0.01	0.00	0.00	-0.07	0.06

notes : see table 2

Table 4 : Employment Growth and Local Inventiveness, various sectors, Canadian Urban System, 2001-2006

	Primary	Construct.	Manufacturing				Business services	
			All	Basic	Medium	High-tech	High-tech	Profes.
Intercept	-0.15	-0.09*	0.11	0.25	-0.17	0.30	1.01***	-1.01***
localpat			0.27*	0.47**				-0.49*
Atlantic	-0.12***		-0.06*					0.13*
Ontario	-0.07**	-0.09***	-0.09***	-0.10***		-0.35		
Prairies					0.18**			
Alberta	0.24***	0.17***		0.13*				0.19**
British Columbia		0.22***			0.19**			
cl8	0.10*		0.13*		0.21**			
cl7				0.05			0.15*	0.15***
cl6								
cl11	0.05*	-0.08**			0.12*	-0.43		
cl14								
LQ2001	-0.03***	0.01*						
sp01			-0.10**		-0.13*		0.17*	
re_01 (x10K)	0.08*						-0.15*	
pg_01					-1.59***			
lp01			-0.04**	-0.04*				0.07**
lpt01_2		0.06***						0.08***
adj r2	0.37***	0.41***	0.11***	0.11***	0.15***	0.02*	0.05**	0.19***
n	191	190	189	192	193	193	197	194
max VIF	1.51	1.55	3.03	2.82	1.48	1.09	1.11	3.24
Moran's I	0.01	0.04	0.03	0.03	0.06*	-0.05	0.07*	-0.04

notes : i) see table 2

ii) LQ2001: concentration (location quotient) of the sector in 2001

Table 5 : Manufacturing employment growth by city location, Canada, 2001-2006

	All		Basic		Medium		High-tech	
	Central	Periph.	Central	Periph.	Central	Periph.	Central	Periph.
Intercept	-0.05	-0.56**	0.22*		0.12*	-1.15**	-0.04	2.69***
localpat			0.60***					4.53***
Atlantic	X		X		X		X	0.86**
Ontario		-1.16***	-0.13***	-0.12*		-0.27**		
Prairies	0.26***							
Alberta	0.12*							
British Columbia	0.19***				0.29***			
cl8								
cl7			0.21***					
cl6			0.13***					-1.22*
cl11			0.14**		0.17**	0.15*		X
cl14					0.20***			-1.25**
LQ2001							0.37	
sp01	-0.10*	-0.11*		-0.15*				
re_01 (x10K)		0.10*				0.21*		
pg_01					-2.10***			-11.19**
lp01	-0.02*		-0.04**					
lpt01_2				-0.07**		0.14***		-0.52***
adj r2	0.13**	0.16*	0.32***	0.17***	0.19***	0.12**	0.04*	0.20***
n	101	85	103	87	101	88	105	88
max VIF	1.31	1.20	3.08	1.08	1.42	1.48	1.00	1.70
Moran's I	0.09*	0.00	-0.01	-0.02	0.10*	0.05	0.00	-0.08*

notes : i) see table 2; ii) the class CL11 was removed from the high-tech, peripheral regressions for reasons of multicollinearity (CL11 was the variable with the highest variance inflation factor, 7.96)