LOCAL SYSTEMS OF INNOVATION: IN SEARCH OF AN ENABLING STRATEGY

Zoltan Acs, John de la Mothe and Gilles Paquet

Working-Paper
95-42

June 1995
Table of contents

Introduction

1. The paradoxical consequences of globalization
2. Meso-systems of innovation
3. Network dynamics and centralized mindset
4. Corroborative evidence: some comparative vignettes
5. Policy implications

Conclusion
Introduction

In the introductory chapter of Nelson's *National Innovation Systems*, a central hypothesis is formulated about "a new spirit of what might be called "technonationalism" ... combining a strong belief that the technological capabilities of a nation's firms are a key source of their competitive prowess, with a belief that these capabilities are in a sense national, and can be built by national action" (Nelson 1993:3). While Richard Nelson and Nathan Rosenberg are careful to explain that one of the central concerns of their 15-country-study is to establish "whether, and if so in what ways, the concept of a "national" system made any sense today", they also add that de facto "national governments act as if it did" (Nelson 1993:5).

Our objective is to raise some questions about this hypothesis and to provide some evidence in support of the "local" systems of innovation as an alternative hypothesis likely to underpin a more effective set of public policies.

In the first section, we deal with the process of *globalization* of economic activities and of its impact on the national production and governance systems. This forces one to confront both what John Naisbitt has called the "global paradox" and what we have called elsewhere the "dispersive revolution" (Naisbitt 1994; de la Mothe & Paquet 1994a). In the second section we suggest that the *innovation process* rarely encompasses the "national" scene but would appear to be congruent with meso regional/sectoral realities that are the genuine source of synergies and social learning. In the third section, we review quickly the main features of *network dynamics* and the way it is stalled by the phenomenon of *centralized mindset*: a strong attachment to "centralized ways of thinking, assuming that every pattern must have a single cause, an ultimate controlling factor" (Resnick 1994), a tendency to bet on centralized means of problem-solving that almost inevitably lead to compulsive centralization and misguided approaches. In the fourth section, we review a portion of the literature on innovation to provide some *evidence* in support of our local systems of innovation hypothesis. In the fifth section, we sketch the *new directions for policy* that flow from our argument.

1. The paradoxical consequences of globalization

Real-life economies are "instituted processes", that is, sets of rules and conventions that vest the wealth-creation process with relative unity and stability by harmonizing the geo-technical constraints that are imposed by the environment with the values and plans found in decisionmakers (Polanyi 1968). Modern economies have evolved substantially over the last century. The wealth-creation process of the late 19th century was mainly instituted as a 'social armistice' between fairly rigid constraints imposed by technology, geography and natural resources endowments, on the one hand, and the less than perfectly coordinated plans of private and public decision-makers, on the other hand. As both constraints and preferences evolved, national economies came to be instituted differently. They evolved often quite differently because of the degrees of freedom afforded them by the extent to which they were protected from the rest of the world by relatively high transportation costs, transaction costs and tariff walls.

In the recent past, the wealth-creation process has changed dramatically. It has become increasingly
dematerialized as its mainsprings ceased to be natural resources and material production and became knowledge and information activities. Transportation costs, transaction costs and tariff walls tumbled. And, as a result of important information economies and of growing organizational flexibility, transnational firms have become capable of organizing production globally and thus to escape to a great extent the constraints nation-states might wish to impose on them. Therefore, economic activity has become less constrained by geography and has even, in many instances, become truly deterritorialized.

Globalization cannot be characterized as a simple process of trade liberalization. To be sure, there has been much liberalization, but firms and nations which have become more exposed internationally have also become increasingly dependent on intangibles like know-how, synergies, and untraded interdependencies. This new techno-economic world has required important changes in the managerial, strategic and political rules of the game.

First, 'firms', 'governments' and 'third-sector organizations' have become rather fuzzy concepts. It is often no longer possible to distinguish the inside and the outside in the complex web of networks and alliances they are enmeshed in. Secondly, the knowledge/information fabric of the new economy has led to the development of a large number of non-market institutions as information and knowledge proved to be poorly handled by the market. Finally, the traditional and narrow economic notion of competition has been replaced by the broader and more sociopolitico-economic notion of competitiveness as a benchmark for assessing the process of wealthcreation and as a guide in designing the requisite web of explicit and organic cooperative links between all stakeholders (Paquet 1990).

As a result, private and public organizations have become more footloose and as such they have become more compatible with a variety of locations, technologies and organizational structures (de la Mothe & Paquet 1994b). They have also been potentially affected to a much greater extent by the synergies, interdependencies, socio-cultural bonds or trust relationships that are capable of producing comparative advantages. Indeed, the central challenge of the new economy has been to find ways to create an environment in which knowledge workers do as much learning as possible -- from their experience, but also from each other, from partners, clients, suppliers, and so on. This entails that, for learning to occur, there must be conversations between and among partners. But since working conversations that create new knowledge can only emerge where there is trust and proximity. These have proved to be essential inputs (Webber 1993).

Two very significant transformations in our modern political economies in the last decades have been ascribable to a large extent to the challenges posed by the new socio-economy: a fragmentation/balkanization of existing national economies and a concurrent massive devolution in the governance system of both private and public organizations.

A. There are many reasons for balkanization to proceed as globalization sets in.

First, global competitiveness has led advanced industrial nations to specialize in the export of products in which they have "technological" or "absolute" advantages, and since those export-oriented
absolute-advantage industries tend to be found in sub-national regions, this has led to the emergence of a mosaic of sub-national geographical agglomerations and regional "worlds of production" characterized by product-based technological learning systems resting, in important ways, on conventions rooted in the cultures of local economic actors (Storper 1992, 1993).

Second, the pressures of globalization have put so much strain on the nation-state that subnational regions and communities have strongly felt a need for roots and anchors in local/regional bonds of ethnicity, language and culture. This tribalism (to use Naisbitt's term) has been reinforced by the fact that it often proved to be the source of a robust entrepreneurial culture and therefore of competitive advantage in the new context (Stoffaes 1987).

Third, the dysfunctionality of the nation-state has triggered the emergence of genuine shared community of economic interests at the regional level, and the dynamics of collective action has led to the rise of the region-state when sub-national governments or loose alliances among local authorities have become active as partners of foreign investors and providers of the requisite infrastructure to leverage regional policies capable of making the region an active participant in the global economy (Ohmae 1993; The Economist 1994).

Fourth, as the region-state emerged, it has been in a position to provide support for the subnational development blocs through the nurturing of complementarities, interdependencies and externalities via infrastructure, networking of economic and business competence, etc. and to dynamize the transformation process at the meso-economic level (Dahmen 1988; de la Mothe & Paquet 1994c). This has in turn reinforced the separate internal dynamics and the resilience of the sub-national systems.

B. Global competitiveness has also triggered a massive devolution in the governance systems of both public and private organizations.

First, the search for speed of adjustment, variety, flexibility and innovation generated by global competitiveness has forced corporations to adapt ever faster and this has led them to "deconstruct" themselves into networks of quasi-autonomous units capable of taking action as they see fit in the face of local circumstances. Managers ceased to be "drivers of people" and became "drivers of learning" (Wriston 1992). This required a shift from hierarchical structures of governance to networking structures that were conducive to innovative conversations.

Second, the same process has been witnessed in the governance of public organizations where the need to do more with less and the growing pressure for more sub-national states to cooperate actively with private organizations to ensure success on the global scene has led governments into massive privatizations or the devolution of power to lower order public authorities (Rivlin 1992; Osborne & Gaebler 1992; Paquet 1994).

Third, this has led to a general praise for the flexibility and genuine souplesse of the federal system as a system of governance for both private and public organizations, and to the general celebration of bottom-up management (O'Toole & Bennis 1992; Handy 1992, 1994).
Fourth, in transforming the governance of economic, social and political organizations, the growing search for flexibility has not stopped at decentralization and privatization strategies. There has been a growing pressure to dissolve permanent organizations so as to allow a maximum open use of all the possibilities of networking. This has led to the proposal that virtual enterprises and governments might provide the ultimate flexibility (Davidow & Malone 1992; de la Mothe & Paquet 1994a). This form of dissolution of governance systems has not only proved to be dynamically efficient but has also led to a reinforcement of community bonds as private and public organizations ceased to be the main source of identification.

2. Meso-systems of innovation

In an economy dynamized by information, knowledge and competence, and consequently balkanized and decentralized, the new relevant units of analysis have to be those that serve as the basis to understand and nurture innovation. Focusing either on the firm or on the national economy would appear to be equally misguided: under the microscope, too much is idiosyncratic and white noise is bound to run high; under the macroscopic lens, much of the innovation and restructuring going on is bound to be missed. One may therefore argue, we think persuasively, that the most useful perspective point is the Schumpeterian/Dahmenian meso-perspective focusing on development blocks, technology districts, sub-national forums, etc. where the learning is really occurring (de la Mothe & Paquet 1994b).

In an evolutionary model, this process of learning and discovery is only one blade of the pair of scissors. The other blade is the interactive mechanism with the context or environment through which selection occurs. Whether the unit of analysis is the technology or the firm, this interactive mechanism is fitness-driven and firm search processes "both provide the source of differential fitness - firms whose R&D turn up more profitable processes of production or products will grow relative to their competitors - and also tend to bind them together as a community" (Dosi and Nelson 1994:162).

What is central to those interactive mechanisms is that they are fueled by dynamic increasing returns to agglomeration. In most cases, these agglomeration economies are bounded, and therefore do not give rise to monopoly by a single region or location, but they generate increasing returns snowballing (Arthur 1990).

We do not know as much as we should about the innovation process, the process of learning and discovery and the process of diffusion of technical and organizational innovations. But as Nelson and Winter (1977) suggested, at the core of these processes is the notion of "selection environment" which is defined as the context that "determines how relative use of different technologies changes over time" (p.61). This context is shaped by market and non-market components, conventions, socio-cultural factors, and by the broader institutional structure. This selection environment constitutes the relevant milieu which may be broader or narrower and may be more or less important in explaining the innovative capacity of a country and a sector/region.

The notion of milieu has been defined as "un ensemble territorial formé de réseaux intégrés de ressources matérielles et immatérielles, dominé par une culture historiquement constituée, vecteur de
savoirs et savoir-faire, et reposant sur un système relationnel de type coopération/concurrence des acteurs localisés" (Lecoq 1989). Consequently, the notion of milieu connotes three sets of forces: (1) the contours of a particular spatial set vested with a certain unity and tonus; (2) the organizational logic of a network of interdependent actors engaged in cooperative innovative activity; and (3) organizational learning based on the dialectics between adapting actors and the adopting milieu (Maillat 1992).

Such a milieu is not a necessary condition for innovation. There are innovations and much learning even in the absence of a dynamic milieu, but such a milieu is likely to bring forth innovation networks; and innovation networks, in turn, are a hybrid form of organization adapted so much better to conditions of technological and appropriation uncertainty than markets or hierarchies, that they are more likely to kickstart the innovation process (DeBresson & Amesse 1991). At the core of the dynamic milieu and of the innovation network are a number of intermingled dimensions (economic, historical, cognitive and normative) but they all depend to a certain degree on trust and confidence, and therefore on a host of cultural and sociological factors that have a tendency to be found mainly in localized networks and to be more likely to emerge on a background of shared experiences, regional loyalties, etc. This is social capital in Coleman's sense and such social and cultural capital plays a central role in both the dynamics and the capacity to learn and transform of meso-systems (Coleman 1988; Saxenian 1994).

The innovation process depends much on the features of a selection environment or milieu.

First, innovation is all about continuous learning and learning does not occur in a socio-cultural vacuum. The innovation network is more likely to blossom in a restricted localized milieu where all the socio-cultural characteristics of a dynamic milieu are likely to be found. Moreover, it is most unlikely that this sort of milieu will correspond to the national territory. Therefore, if one is to identify dynamic milieux or milieux porteurs as likely systems on which one might work to stimulate innovation, they are likely to be local or regional systems of innovation.

Second, some geo-technical forces would appear to generate meso-level units where learning proceeds faster and better. As Storper argues, "in technologically dynamic production complexes ... there is a strong reason for the existence of regional clusters or agglomerations. Agglomeration appears to be a principal geographical form in which the trade-off between lockin technological flexibility (and the search for quasi-rents), and cost minimization can be most effectively managed, because it facilitates efficient operations of a cooperative production network. Agglomeration in these cases, is not simply the result of standard localization economies (which are based on the notion of allocative efficiency in minimizing costs), but of Schumpeterian efficiencies" (Storper 1992:84).

Third, the deconstruction of national economies, the dispersive revolution in governance, the rise of region-states and the growth of the new tribalism would tend to provide a greater potential for dynamism at the meso level. But Storper has argued that "codes, channels of interaction, and ways of organizing and coordinating behaviors" are what makes learning possible (p.85). He feels that the confluence of issues (learning, networks, lock-in, conventions and types of knowledge) must be
rooted in political-economic cultures, rules and institutions and that in many countries these are
highly differentiated at the regional level. Therefore one region may trigger technological learning
and innovation networks in one sub-national area much faster than in others. Canada, the USA and
Mexico are such countries where one may reasonably detect a mosaic of political-economic cultures,
rules and conventions with differential innovative potential (Maddox & McGee 1994). Consequently,
one may say that there is a genuine "territorialization of learning" in such a Schumpeterian world.

3. Network dynamics and centralized mindset

Subnational areas have proved to be better loci for "conversations" likely to foster fast learning.
Indeed, it is argued by the defenders of the notion of local system of innovation that such subnational
areas are a more supportive underground for the development of multi-stakeholders networks and
new forms of cooperation and relational exchange. But this has not detered those who have a strong
taste for national across-the-broad interventions. The techno-nationalists emphasize the importance
of the national network of institutions, acting as a system and providing the foundations and the
underpinnings of the innovation system. This leads them to bet on policies designed to act on the
national institutions to stimulate innovations.

The opposition between local and national systems of innovation is rooted in the contrast between
two dynamics: the bottom-up dynamics of networks and the top-down dynamics built on the
centralized mindset.

A. Bottom-up network dynamics

The paradoxical consequences of globalization have been not only to generate balkanization but also
to create the need for new forms of organizations. Hierarchies have limited learning abilities and
markets have limited capacities to process information effectively. Networks and alliances are ways
to counter these failures, ways to combine the benefit of being large and small at the same time.

The network is not, as is usually assumed, a mixed form of organization existing halfway on a
continuum ranging from market to hierarchy. Rather, it is a generic name for a third type of
arrangement built on very different integrating mechanisms: networks are consensus/inducement-
oriented organizations and institutions. This suggests that instead of the market-hierarchy dichotomy,
one should bet on a partition of institutions and organizations according to three principles of
integration: (a) those associated with threat/coercion, (b) those associated with exchange, and (c)
those associated with consensus and inducement-oriented systems.

This more useful way of classifying institutions has been used by Karl Polanyi (1968 [orig. 1957];
Francois Perroux (1960); Kenneth Boulding 1970) and more recently by Shumpei Kumon (1992).

Networks have two sets of characteristics: those derived from their dominant logic (consensus and
inducement-oriented systems) and those derived from the dominant intelligence that emerges from
their structure.
The consensus dominant logic does not abolish power but it means that power is distributed. A central and critical feature of networks is the emphasis on voluntary adherence to norms. While this voluntary adherence does not necessarily appear to generate constraints per se on the size of the organization, it is not always easy for a set of shared values to spread over massive disjointed transnational communities: free riding, high transaction costs, problems of accountability, etc. impose extra work. So the benefits in terms of leanness, agility and flexibility are such that many important multinationals have chosen not to manage their affairs as a global production engine, but as a multitude of smaller quasi-independent units coordinated by a loose federal structure, because of the organizational diseconomies of scale in building a clan-type organization (O'Toole/Bennis 1992; Handy 1992).

As for the structural characteristics of the network, it complements nicely its dominant logic for networked intelligence, as embodied for instance in a company or an organization, will have the following traits: it will be distributed, decentralized, collaborative and adaptive (Kelly 1994: 189). This network structure based on reciprocity and trust is a self-reinforcing mechanism for it breeds trust and reciprocity, thereby increasing the social capital and generating increasing returns. In that sense, reciprocity that is based on voluntary adherence generates lower costs of cooperation and therefore stimulates more networking as social capital accumulates with trust. The experiences in Emilia-Romagna described by Putnam (1993), its echo effect in Denmark or parallel developments in the Silicon Valley described by Saxenian (1994) are all pointing in the same direction. The site of a dense concentration of overlapping networks of solidarity generates wealth-creation on a surprising scale.

Some have argued that new technologies might well generate 'cyberhoods' that would be as potent as neighbourhoods and that maybe the "local" setting for for such networks of solidarity or for a cultural milieu likely to generate much innovation could become truly territorialized and completely "virtual". But even network enthusiasts are not quite ready to consider the "virtual community" as anything more than a poor simulacrum of the real community and consequently see it as being unlikely to generate the requisite degree of passion and commitment that is needed to fuel social capital accumulation on the appropriate scale (Rheingold 1993).

The growth of network markets in a number of sectors where mass customization is important has generated a new form of externalities that has yielded important increasing returns, some snowballing effects and some possibilities of lock-in. This is the logic of network economies. But the network externalities and spillovers are not spreading in a frictionless world. Networking casts much more of a local shadow than is usually presumed: "space becomes ever more variegated, heterogeneous and finely textured in part because the processes of spatial reorganization ... have the power to exploit relatively minute spatial differences to good effect (Harvey 1988). Consequently, a network does not extend boundlessly but tends instead to crystallize, around a unifying purpose, mobilizing independent members through voluntary links, around multiple leaders in integrated levels of overlapping and superimposed webs of solidarity. This underscores the enormous importance of "regional business cultures" and explains the relative importance of the small and medium-sized enterprises networks in generating new ideas (Lipnack and Stamps 1994).
Not only are networks generating social capital and wealth, they have also been closely associated with a greater degree of progressivity of the economy, that is with a higher degree of innovativeness and of capacity to transform because networks cross boundaries. Indeed, boundary-crossing networks are likely to ignite much innovativeness because they provide an opportunity for reframing and recasting perspectives and for questioning the assumptions that have been in good currency. One might suggest a parallel between boundary-crossing and migration into another world in which one's home experience serves as a useful contrast to the new realities. Much of the buoyant immigrant entrepreneurship is rooted in this dual capacity to see things differently and to network within and across boundaries. In the face of placeless power in a globalized economy, seemingly powerless places with their own communication code on a historically specific territory are fitful terrains for local collaborative networks.

B. Top-down centralized mindset

In the face of strong presumptions regarding the existence of meso innovation systems, it is surprising to find that so little done has been to escape the mindset of "national systems of innovation". The reason for this bias is, however, not very difficult to understand. Since the cost of thinking is not zero, humans adopt paradigms and mindsets to routinize their thinking. Technonationalism's appeal is of this sort.

Mitchel Resnick has analyzed the travers that explains that, in an era of decentralization in every domain, centralized thinking is remaining prevalent in our theories of knowledge, in our ways of analyzing problems, and in our search for policy responses. "Politicians, managers and scientists are working with blinders on, focusing on centralized solutions even when decentralized approaches might be more appropriate, robust, or reliable" (Resnick 1994:36). As Resnick explained, "the centralized mindset is not just a misconception of the scientifically naive", one may find ample evidence that in science, in governance, there is a strong resistance to the idea of complexity being formed from a decentralized process. The resistance to evolutionary theory is of that ilk. It is more reassuring to presume that every pattern must have a single cause, and therefore an ultimate controlling factor.

This explains the opposition to a bottom-up explanation when this alternative cosmology has been suggested - (Science Council of Canada 1984, 1990) even when documentary evidence had been mounted to show that such an approach was not only promising but de facto building on already impressive accomplishments in a number of metropolitan areas (Davis 1991).

More than a decade after the suggestion by the Science Council that metropolitan technology councils might be the appropriate lever to energize local systems of innovation, the idea is still in limbo. The centralized "national system of innovations" continues to dominate the policy scene, and the view of a fragmented and localized set of systems of innovation that could only be nurtured from the periphery is still not in good currency (Paquet 1992; de la Mothe & Paquet 1994d; Paquet and Roy 1995).
4. **Corroborative evidence: some comparative vignettes**

We draw from three sets of corroborative evidence. First, recent exploratory work on network economies have underlined the importance of local spillovers or externalities, but the extent to which these spillover effects are indeed localized has not been sufficiently emphasized. Second, a whole body of observations and descriptive/ethnographical and empirical studies using alternative data bases on innovative activities would appear to provide collateral evidence. Finally, the existing literature of the historical and case study variety shows that indeed innovation systems have blossomed locally.

The 'evidence' provided through these three routes supports our hypothesis only in a limited and oblique way. However, in toto, we feel that a persuasive argument may be constructed out of these many less-than-fully reliable parts.

A. **Network economies**

A first element of support has emerged in a somewhat oblique way from some recent work on network economies. The economic literature on networks has generated a rekindling of interest in the role of externalities in supply after decades of neglect. At the core of this renewal is the explosion of the new information and communication technologies. These technologies are at the core of a wave of innovations generated and diffused over the last decades and underpin the new centrality of increasing returns and economies of scale. It is to the increased centrality of communication networks that one may ascribe the new emphasis on the basic characteristics of information: interdependence, inappropriability and externality (Antonelli 1992:6).

The analysis of telecommunication networks has served as a réglateur. They represent a sector with a particularly high degree of heterogeneity of components, of technical interrelatedness, of complexity of technological change, and they are exemplars of a sector with much irreversibility in investment, important scale economies and increasing returns and a broad array of externalities. Indeed, in the "paradigmatic network industry the market demand schedule slopes upwards (due to demand externalities) and the market supply schedule slopes downwards (due to indivisibilities and supply externalities)" (David 1992:104). But the most crucial aspect of this literature is the component suggesting that "these features apply not only to the increasing number of sectors affected by the spreading of information and communication technologies, but more generally to all the processes of growth and change" (Antonelli 1992:15).

If such is the case, some interesting results are emerging in six major areas (Antonelli 1992):

a. the rate of introduction of innovations by a firm would appear to be more and more influenced by its capacity to cooperate with other firms;

b. the success of a new technology depends on adoption externalities;

c. network externalities are determinant in the selection of a technology;
d. key sectors are the providers of externalities through an array of untraded interdependencies and linkages;

e. proximity is a strong necessary condition to take advantage of externalities generated by others;

f. network firms are the result of attempts by firms to internalize externalities.

A critical examination of this new world reveals that three factors will be central to the new dynamics:

(1) networks represent an intermediate solution between the dynamic efficiency and innovativeness of market specialization and the static efficiency, coherence and compatibility effected by hierarchical integrated organizations;

(2) selective cooperation is the new pivotal tool for economic agents to internalize externalities;

(3) any change is likely to have a strong *local character* (Piore 1992:443; Antonelli 1992:23).

These factors may vary from sector to sector but are at the source of the various clusterings that lead to social learning and to the dynamic reinforcement of the cluster (Porter 1990).

**B. Empirical evidence**

In a series of monographs and papers (Acs 1990; Acs and Audretsch 1990, 1992; Acs, Audretsch and Feldman 1992, 1994a, 1994b; Acs, FitzRoy and Smith 1994) Acs and his associates have developed new sources of data on innovative activity in the United States beyond the traditional measure using patents. They have critically analyzed new data developed by others, in an effort to provide extensive evidence of the important innovative activity of small firms and to throw some light on the important sectoral/locational/organizational factors that explain the different dynamics of innovative activity of large and small firms in different types of industries and locations. These studies have suggested that small firms are the recipients of important spillovers from knowledge generated in larger centers in firms and universities. These external effects differ from industry to industry but depend much on organizational and locational factors. These studies have provided important new evidence to help us understand the texture of local systems of innovation and the potential levers that might be used to design a new generation of public policies based on this new learning.

One of the important results generated by these studies is the detailed documentation that R&D spillovers which are one of the sources of externalities are greatly facilitated by the "geographical coincidence" of the different partners (universities, research labs, firms) within the state. Not only does innovative activity increase as a result of high private corporate expenditures on R&D, but it increases also as a result of research undertaken by universities within the area.

While it is difficult to generalize because of the fact that the patterns of innovative activity vary
greatly from industry to industry and because of the fact that local embedding is often intermingled with global networks, it is clear from the literature that the local milieu can be regarded very often as the collective entrepreneur and innovator rather than the firm. Obviously the capacity for collective entrepreneurship depends a lot on socio-cultural factors resulting from the history of the region as Putnam has shown in the case of Italy. But much can be gained from the creation of a robust and decentralized system of institutional support to ensure that technical and commercial knowledge is diffused fast and as widely as possible thereby catalyzing the process of social learning (Best 1990; Todding 1994; Cooke and Morgan 1994).

Bernstein has produced important work over the last decade demonstrating the importance of R&D spillovers in Canada (Bernstein 1986), but, to our knowledge, there has been little done in Canada to date to organize systematically data collection on the innovative process (expenditures, output, etc.) in order to be able to calibrate the local nature of these external effects.

There has been a bit more systematic work on the landscape of innovative activity in the United States using both traditional R&D expenditures and direct measures of innovative activity like the number of innovations commercially introduced derived from a score of technology, engineering and trade journals listing innovations and new products. It has shown that innovative activity is not evenly spread over the territory. Both R&D expenditures by industry and universities are clustered and they have important spatial spillovers that territorialize innovative activity. While small firms or large firms may dominate the scene, the clustering effect is quite clear in the data presented in Table I for the U.S. states.

This sort of clustering activity is even more evident at the county level. Table 2 shows the number of innovations for the 26 most innovative counties in the United States. One can see clearly that most of the innovations are clustered in a few counties. For instance, five counties in California accounted for 80% of the innovations in the state.

None of this is a robust proof that local systems of innovation exist or that public policy should be mainly directed to the local level. We only suggest that there are undeniably important spatial spillovers and that, in an oblique way, the available data on state and county innovative activity would appear to corroborate the local systems of innovation hypothesis.
Table 1
Innovative Output in Large and Small Firms and R&D Inputs by State\(^1\)

<table>
<thead>
<tr>
<th>State</th>
<th>Total Innovations</th>
<th>Large Firm Innovations</th>
<th>Small Firm Innovations</th>
<th>Industry R&amp;D Expenditures</th>
<th>University Research</th>
</tr>
</thead>
<tbody>
<tr>
<td>CALF</td>
<td>974</td>
<td>315</td>
<td>659</td>
<td>3883</td>
<td>710.4</td>
</tr>
<tr>
<td>NY</td>
<td>456</td>
<td>180</td>
<td>276</td>
<td>1859</td>
<td>371.0</td>
</tr>
<tr>
<td>NJ</td>
<td>426</td>
<td>162</td>
<td>264</td>
<td>1361</td>
<td>70.8</td>
</tr>
<tr>
<td>MASS</td>
<td>360</td>
<td>148</td>
<td>212</td>
<td>954</td>
<td>245.3</td>
</tr>
<tr>
<td>PA</td>
<td>245</td>
<td>104</td>
<td>141</td>
<td>1293</td>
<td>139.2</td>
</tr>
<tr>
<td>ILL</td>
<td>231</td>
<td>100</td>
<td>131</td>
<td>894</td>
<td>254.9</td>
</tr>
<tr>
<td>OHIO</td>
<td>188</td>
<td>76</td>
<td>112</td>
<td>926</td>
<td>76.2</td>
</tr>
<tr>
<td>CONN</td>
<td>132</td>
<td>77</td>
<td>55</td>
<td>650</td>
<td>54.7</td>
</tr>
<tr>
<td>MICH</td>
<td>112</td>
<td>61</td>
<td>51</td>
<td>1815</td>
<td>103.2</td>
</tr>
<tr>
<td>MINN</td>
<td>110</td>
<td>64</td>
<td>46</td>
<td>399</td>
<td>55.7</td>
</tr>
<tr>
<td>WISC</td>
<td>86</td>
<td>33</td>
<td>53</td>
<td>224</td>
<td>65.0</td>
</tr>
<tr>
<td>FLA</td>
<td>66</td>
<td>21</td>
<td>45</td>
<td>375</td>
<td>70.1</td>
</tr>
<tr>
<td>GA</td>
<td>53</td>
<td>20</td>
<td>33</td>
<td>78</td>
<td>57.8</td>
</tr>
<tr>
<td>IND</td>
<td>49</td>
<td>20</td>
<td>29</td>
<td>398</td>
<td>51.3</td>
</tr>
<tr>
<td>COLO</td>
<td>42</td>
<td>13</td>
<td>29</td>
<td>167</td>
<td>77.2</td>
</tr>
<tr>
<td>ARIZ</td>
<td>41</td>
<td>23</td>
<td>18</td>
<td>201</td>
<td>37.4</td>
</tr>
<tr>
<td>VA</td>
<td>38</td>
<td>19</td>
<td>19</td>
<td>207</td>
<td>45.9</td>
</tr>
<tr>
<td>NC</td>
<td>38</td>
<td>16</td>
<td>22</td>
<td>193</td>
<td>64.6</td>
</tr>
<tr>
<td>RI</td>
<td>24</td>
<td>4</td>
<td>20</td>
<td>32</td>
<td>14.9</td>
</tr>
<tr>
<td>OKLA</td>
<td>20</td>
<td>12</td>
<td>8</td>
<td>93</td>
<td>19.9</td>
</tr>
<tr>
<td>IOWA</td>
<td>20</td>
<td>12</td>
<td>8</td>
<td>135</td>
<td>46.4</td>
</tr>
<tr>
<td>KANS</td>
<td>15</td>
<td>3</td>
<td>12</td>
<td>66</td>
<td>26.6</td>
</tr>
<tr>
<td>UTAH</td>
<td>11</td>
<td>2</td>
<td>9</td>
<td>72</td>
<td>32.5</td>
</tr>
<tr>
<td>NEB</td>
<td>9</td>
<td>1</td>
<td>8</td>
<td>9</td>
<td>20.4</td>
</tr>
<tr>
<td>KY</td>
<td>9</td>
<td>6</td>
<td>3</td>
<td>72</td>
<td>17.5</td>
</tr>
<tr>
<td>LA</td>
<td>5</td>
<td>0</td>
<td>5</td>
<td>65</td>
<td>33.4</td>
</tr>
<tr>
<td>ARK</td>
<td>5</td>
<td>5</td>
<td>0</td>
<td>9</td>
<td>12.0</td>
</tr>
<tr>
<td>ALA</td>
<td>5</td>
<td>0</td>
<td>5</td>
<td>54</td>
<td>28.3</td>
</tr>
<tr>
<td>MISS</td>
<td>4</td>
<td>1</td>
<td>3</td>
<td>420</td>
<td>61.4</td>
</tr>
</tbody>
</table>

\(^1\)Industry R&D and University research expenditures are in millions of 1972 dollars and are taken from Jaffe (1989).
## Table 2
Number of Innovations by County
(Top 26 Counties)

(1982)

<table>
<thead>
<tr>
<th>No</th>
<th>County</th>
<th>CTYCODE</th>
<th>STATE</th>
<th>STACODE</th>
<th>INNOVATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>SANTA CLARA</td>
<td>085</td>
<td>CA</td>
<td>06</td>
<td>386</td>
</tr>
<tr>
<td>2</td>
<td>LOS ANGELES</td>
<td>037</td>
<td>CA</td>
<td>06</td>
<td>178</td>
</tr>
<tr>
<td>3</td>
<td>COOK</td>
<td>031</td>
<td>IL</td>
<td>17</td>
<td>155</td>
</tr>
<tr>
<td>4</td>
<td>MIDDLESEX</td>
<td>017</td>
<td>MA</td>
<td>25</td>
<td>145</td>
</tr>
<tr>
<td>5</td>
<td>NORFOLK</td>
<td>021</td>
<td>MA</td>
<td>25</td>
<td>121</td>
</tr>
<tr>
<td>6</td>
<td>ORANGE</td>
<td>059</td>
<td>CA</td>
<td>06</td>
<td>117</td>
</tr>
<tr>
<td>7</td>
<td>BERGEN</td>
<td>003</td>
<td>NJ</td>
<td>34</td>
<td>90</td>
</tr>
<tr>
<td>8</td>
<td>NEW YORK</td>
<td>061</td>
<td>NY</td>
<td>36</td>
<td>82</td>
</tr>
<tr>
<td>9</td>
<td>FAIRFIELD</td>
<td>001</td>
<td>CT</td>
<td>09</td>
<td>76</td>
</tr>
<tr>
<td>10</td>
<td>NASSAU</td>
<td>059</td>
<td>NY</td>
<td>36</td>
<td>73</td>
</tr>
<tr>
<td>11</td>
<td>DALLAS</td>
<td>113</td>
<td>TX</td>
<td>48</td>
<td>64</td>
</tr>
<tr>
<td>12</td>
<td>SAN DIEGO</td>
<td>073</td>
<td>CA</td>
<td>06</td>
<td>63</td>
</tr>
<tr>
<td>13</td>
<td>SUFFOLK</td>
<td>103</td>
<td>NY</td>
<td>36</td>
<td>62</td>
</tr>
<tr>
<td>14</td>
<td>CUYAHOGA</td>
<td>035</td>
<td>OH</td>
<td>39</td>
<td>62</td>
</tr>
<tr>
<td>15</td>
<td>ESSEX</td>
<td>013</td>
<td>NJ</td>
<td>34</td>
<td>57</td>
</tr>
<tr>
<td>16</td>
<td>WESTCHESTER</td>
<td>119</td>
<td>NY</td>
<td>36</td>
<td>54</td>
</tr>
<tr>
<td>17</td>
<td>RAMSEY</td>
<td>123</td>
<td>MN</td>
<td>27</td>
<td>49</td>
</tr>
<tr>
<td>18</td>
<td>MONTGOMERY</td>
<td>091</td>
<td>PA</td>
<td>42</td>
<td>45</td>
</tr>
<tr>
<td>19</td>
<td>PHILADELPHIA</td>
<td>101</td>
<td>PA</td>
<td>42</td>
<td>44</td>
</tr>
<tr>
<td>20</td>
<td>HENNEPIN</td>
<td>053</td>
<td>MN</td>
<td>27</td>
<td>42</td>
</tr>
<tr>
<td>21</td>
<td>MORRIS</td>
<td>027</td>
<td>NJ</td>
<td>34</td>
<td>42</td>
</tr>
<tr>
<td>22</td>
<td>ALAMEDA</td>
<td>001</td>
<td>CA</td>
<td>06</td>
<td>39</td>
</tr>
<tr>
<td>23</td>
<td>MIDDLESEX</td>
<td>023</td>
<td>NJ</td>
<td>34</td>
<td>36</td>
</tr>
<tr>
<td>24</td>
<td>HARRIS</td>
<td>201</td>
<td>TX</td>
<td>48</td>
<td>35</td>
</tr>
<tr>
<td>25</td>
<td>SOMERSET</td>
<td>035</td>
<td>NJ</td>
<td>34</td>
<td>34</td>
</tr>
<tr>
<td>26</td>
<td>MONROE</td>
<td>055</td>
<td>NY</td>
<td>36</td>
<td>34</td>
</tr>
</tbody>
</table>

Source: Data from WORKMSA./ Analysis by University of Baltimore.
C. Case studies

The dossier of case studies tending to show some evidence that local systems of innovation exist and have a dynamic of their own is very extensive. It ranges from commemorative and boosterism writings, to carefully documented cases in monographs and books, to anecdotal evidence quoted on the occasion of a paper covering a broader territory, to tentative syntheses on the basis of all of the above. While it is difficult to derive precise general propositions from this variegated material, it provides a very rich file documenting the ways in which local systems of innovation have emerged and evolved.

There is no unanimity in this dossier. One finds strident critics and vehement apologists of local systems of innovation. But the vast majority of the case work is strongly in support of the existence and importance of LSIs, and very much can be learned from these documents about the types of policies that have had determining impacts on the success of these ventures.

To mention only a few samples of such material, one may cite Putnam's work on the civic communities of Italy (1992), Saxenian's work comparing Route 128 and the Silicon Valley (1994), the work of economic geographers like Storper (1992, 1993) and the work of Davis, Andrew et al, and Voyer and Ryan for the Canadian scene (Davis 1991; Andrew et al. 1993; Voyer and Ryan 1994). They all document the importance of proximity and the centrality of community, linguistic and related dimensions as the fabric of the socio-cultural underground on which sub-national systems of innovation are built. Yet it must be recognized that there has been a lag in the recognition of the bottom-up dynamics in Canada vis-à-vis what one may observe in Europe.

From these case studies, one may derive a few elements of learning:

(1) a common thread is the way in which relationships develop between private concerns and both the community and the public actors, and the way in which "enabling agencies" foster collaboration; whether these agencies have materialized in formal mechanisms of governance like metropolitan technology councils or have simply crystallized in the form of an ethos, the instruments of collective coordination based on appeals to solidaristic local values, vision and culture are of central import (Hollingsworth 1993);

(2) another common thread is the importance of leadership; leadership is "what enables the complex interinstitutional and intersectoral partnerships to develop and become operational" and it would appear that the ability of communities to shape their future depends much more on social than on technological processes (Davis 1991:12);

(3) a third common thread is the great fragility of many local systems of innovations because of the fact that they are "weakly institutionalized"; this is the sort of weakness that suggests the way in which the senior governments might be of most help in getting the local communities to help themselves, i.e. in providing the enabling support to get the communities to invent new instruments and design new policy approaches. But there is also evidence of very robust local systems of innovations (Cooke and Morgan 1994; Saxenian 1994).
5. **Policy implications**

The Canadian landscape is sharply differentiated from region to region, and national and provincial institutions like research laboratories and universities and colleges have important and differential local impacts that are very much shaped by proximity as well as by the industrial, legal and cultural backgrounds. This very diversified industrial landscape requires a thorough sub-national analysis to expose the real causes and sources of innovation and competitiveness. The same point can be made about the USA with the extraordinary diversity of its regional/sectoral landscape, its various sub-cultures, its very different state strategies, its network of state universities, etc. And the same may be said also of Mexico where the 32 states may not weigh equally in the innovation equation, but where a certain degree of differentiation is already obvious. A recent survey of science in Mexico has revealed to the rest of North America that there is a much greater variety on the innovation system front in Mexico than one might gather from the superficial press coverage in the rest of North America (Maddox & Gee 1994).

We know that much of the progress of the wealth-creation process in the three countries is ascribable to the innovation system and is rooted in product-based technology-learning à la Storper, and we know that these innovativeness/competitiveness capabilities are based to a great extent on what Storper has called "conventions of identity and participation" (1993:450). This remains however an unexplored comer in the new literature on economic development.

There is a strong presumption that the regional worlds of production may not have been sufficiently recognized as the source/cause of innovation and that a better use of the "conventions of identity and participation" as a lever for policy-makers might pay off handsome dividends. Some have even argued that the federal policies in the post-World War II period in the United States have "displaced the role of state governments as actors in this innovation system and contributed to some weakening in the informal ties that linked many corporate and academic research institutions" (Nelson 1993: 61-2).

If this is reasonably accurate, one must therefore inquire as to the implications of this new centrality of networks, selective cooperation and local character in systems of innovation for the policy agenda. This would require that the policy framework be redefined.

First the new policy world would need to be redefined away from the old centralized scheme of goals-cum-guidance control mechanism toward a new framework based on intelligence and innovation. This in turn requires that the appropriate discursive communities be identified and that I be generated or constructed in order for the local system to jell.

Second, there will be a need for determining the sort of I likely to trigger effective selective cooperation i.e. the "conventions of of identity and participation" necessary for a bottom-up policy to work.

Finally, if the local system of innovations is to crystallize, there must be a recognition of the need for the cognitive and learning infrastructures necessary at the sub-national level but also
of the need to harmonize differently the different layers of governance characterizing the policy world.

A. Toward a network policy

The roundtable concept constitutes a loose on-going consultation process that is quite satisfactory at the national level. But what can be generated through such a vehicle is nothing more than general guiding principles or more probably a sense of the limits or the boundaries defining what is unacceptable. This can also help delineate the zone of potential interventions, the least undesirable action plans likely to foster the emergence of robust bottom-up strategies.

This calls for on-going discussions with all the meaningful stakeholders in meso-forums capable of focusing the strategic search at the middle-range level where synergies and interactions are most visible and the interventions most likely to be effective. Clusters, networks, filières are the new units of analysis and the most useful meso-forums are likely to be provided by the sort of metropolitan technology councils that the Science Council of Canada proposed in 1984 or through an active strategy of support for business networks.

Already the Canadian government has put forward a National Business Networks Demonstration program built on wide information dissemination on networks, roundtables to promote the concept of network and network broker training. This will support thirty sectorally and regionally balanced networks. This concept can easily be extended to stimulating networks of innovators (Bianchi and Bellini 1991). These interventions can take many forms - from encouraging agents to see themselves as part of networks to the promotion of "collective agents" or service centers aimed at minimizing the costs of coordination and enabling greater specialization.

B. Toward conventions of identity and participation

These forums will need to develop conventions based on local values that might serve as pillars of the local systems of innovations. While these may vary considerably from Quebec et Saskatoon, from Route 128 to the Silicon Valley, they will provide the foundations of the local systems of innovations. Only detailed case studies of the different milieux can provide information about the nature of workable conventions and the relative valence of the different players in the sort of evolving contract likely to lead to innovationness and progressivity.

Government may play an important role in shaping those conventions in an oblique way through networking strategies and through action aimed at encouraging the creation of "promotional networks" and associations likely to provide the underpinnings for the development of relational contracting, alliances and joint ventures in related areas (Hollingsworth 1993).

There have been a sufficient number of experiments in Canada and elsewhere for one to be able to define the contours of what might be the framework for conventions capable of weaving the network together. While local intervention is essential in this bottom-up strategy, there is much that can be done at other levels to help design the sorts of "moral contract" capable of generating the requisite
degree of cooperation to stimulate innovation (Acs 1990; Davis 1991).

C. Toward a distributed governance system

It will be important for governments to provide the necessary social overhead capital and the techno-economic infrastructure necessary for the requisite coordination to be realized. Such infrastructure is meant to be part of an enabling strategy and should obviously be directed at the meso-level where the requisite amount of trust may be generated and the most effective alliances evolve.

But, governments cannot be simply suppliers of infrastructure. They must actively promote, jointly and transversally through negotiated arrangements to cross jurisdictional boundaries, the integration of all the various sources of existing infrastructure (industry, academies, consortia, and so on) and this must be part of a multi-staged strategy in which local clusters and industrial corridors are leveraged and facilitated (and thus integrated) by technology infrastructure (Tassey 1992). More importantly however, one must ensure that the choice of the governance structure is not simply geared to reducing transaction costs, but transition costs as well from one technological situation to another through learning (Ciborra 1992).

Conclusion

A presumption, put forward very cautiously and tentatively by a few scholars a few years ago, suggested that the most effective way to analyze the innovation system and to intervene strategically in it is to tackle the problem at the "national" level. Yet, much recent work has raised serious questions about this hypothesis. Too many forces at work in the world economy would appear to suggest that, as globalization proceeds, national disintegration occurs, and subnational components gain more importance. Consequently, focusing on sub-national units of analysis would, in all likelihood, provide better insights into the workings of the "real worlds of production" and better levers for policy interventions on the innovation front.

One might have been expected that observers, researchers and policy-makers would have been led to focus more of their work and analyses on meso-innovation systems. However this would be discounting unduly the power of the centralized mindset at work in so many sectors of politics, management and science. This mindset has maintained the dominion of the centralized machine-model of the socio-economy in place and has kept the decentralized garden-model at bay. The result is a rather misguided pursuit and concatenation of ethereal "national systems" where there are only "regional/sectoral" systems.

Chasing êtres de raison can however be a most successful national sport as long as one works hard enough at promoting it and as long as nobody dares, whatever the body of evidence, to question the very existence of the "national system". Consequently the literature on national systems of innovation has become a cottage industry and is in danger of evolving into a compass in the hands of federal policy-makers determined to intervene centrally to catalyze the innovation systems and to make our socio-economies more innovative and more effective engines of wealth creation. The conjectures one can reasonably utter about the features of government policy to promote innovation
in Canada, Mexico and the United States in the next decade would appear to point to the continuation of these centralized initiatives.

Yet the costs of such "national" strategies are likely to be very high if, as we surmise, what is called for is a bottom-up policy, consequently, it may not be unimportant to call for a return to the drawing board before it is too late:

(1) a return to the cautious and tentative language used by Richard Nelson and to the realization that the hypothesis of "national systems of innovation" has not been validated yet, and

(2) a plea for a more serious and careful examination of the alternative hypothesis suggested by the new paradigms of economic geography and clearly spelled out in the work we have referred to above (Benko & Lipietz 1992).

ZJA/JdIM/GP
April 1995
References


