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Regional Innovation Systems: A Critical Synthesis

David Doloreux and Saeed Parto

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REGIONAL INNOVATION SYSTEMS: A CRITICAL SYNTHESIS

David Doloreux and Saeed Parto

Abstract

In recent years, the concept of *Regional Innovation Systems* has evolved into a widely used analytical framework generating the empirical foundation for innovation policy making. Yet, the approaches utilizing this framework remain ambiguous on such key issues as the territorial dimension of innovation, e.g., the region, and the apparently important role played by “institutions” or the institutional context in the emergence and sustenance of regional innovation systems. This paper reviews and summarizes the most important ideas and arguments of the recent theorizing on regional innovation systems to provide the basis for a critical examination of such issues as (1) definition confusion and empirical validation; (2) the territorial dimension of regional innovation systems; and (3) the role of institutions. Far from having the last word on these issues, our intent in this paper is to draw attention to the definitional deficiencies of regional system of innovation theorizing and the need to address them.

Key-words: Regional innovation systems, institutions, regions, research, policy

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1. INTRODUCTION

The rise in the popularity of the concept of regional innovation systems has been in part driven by the increased intensity of international competition in a globalizing economy, the apparent shortcomings of traditional regional development models and policies, and the emergence of successful clusters of firms and industries in many regions around the world (Enright, 2001). One result has been the rediscovery by many academics of the importance of the regional scale and the importance of specific and regional resources in stimulating the innovation capability and competitiveness of firms and regions (Asheim *et al.*, 2003; Cooke, 2003; Wolfe, 2003; Isaksen, 2002; Malmberg and Maskell, 2002). Thus, it is argued that firm-specific competencies and learning processes can lead to regional competitive advantages if they are based on localized capabilities such as specialized resources, skills, institutions and share of common social and cultural values (Maskell and Malmberg, 1999). In other words, regional development ensues as competitiveness occurs in places where localized capabilities such as institutional endowment, built structures, knowledge and skills exist. The literature on regional innovation systems has provided substantial description and analysis of relationships between innovation, learning and economic performance of particular regions.

Attempts to explain social and institutional conditions of regional competitiveness have also resulted in the emergence of such concepts as ‘learning region’ (Morgan, 1997; Florida, 1995), ‘innovative milieu’ (Crevoisier, 2001; Maillat, 1998), ‘industrial district’ (Becatinni, 1992), ‘local productive system’ (Courlet, 2000). Three broad dimensions of the literature on regional innovation system concern us in this paper. First are the interactions between different actors in the innovation process, particularly the interaction between users and producers, but also between business and the wider research community. Second is the role of institutions and the extent to which innovation processes are institutionally embedded in the setting of systems of production. Third is the reliance by policy makers on analyses that attempt to operationalize the concept of regional innovation systems. We contend that the interactions between the actors in regional innovation systems have been insufficiently explored while the institutional context of these interactions has been by and large overlooked. As a result, the validity of the recommendations for innovation policy making based on the current analyses of regional innovation systems is somewhat questionable.

The aim of this paper is to review and summarize the most important ideas and arguments of the recent theorizing on regional innovation system, and to present a systemic account of the shortcomings and challenges in research on regional innovation systems.

2. REGIONAL INNOVATION SYSTEMS FROM WITHIN AND BEYOND

2.1 Antecedents and current discourse on regional innovation system

The concept of regional innovation system has been gaining much attention from policy makers and academic researchers since the early 1990s. The approach has received considerable attention as a promising analytical framework for advancing our understanding of the innovation process in the regional economy (Asheim *et al.*, 2003; Isaksen, 2002; Cooke *et al.*; 2002). The popularity of the concept of regional innovation system is closely related to the emergence of regionally identifiable nodes or clusters of industrial activity as well as the surge in regional innovation policies where the region is deemed as the most appropriate scale at which to sustain innovation-based learning economies (Asheim and Isaksen, 1997).

The concept of regional innovation systems has no commonly accepted definitions, but usually is understood as a set of interacting private and public interests, formal institutions and other organizations that function according to organizational and institutional arrangements and relationships conducive to the generation, use and dissemination of knowledge (Doloreux, 2003). The basic argument is that this set of actors produce pervasive and systemic effects that encourage firms within the region to develop specific forms of capital that is derived from social relations, norms, values and interaction within the community in order to reinforce regional innovative capability and competitiveness (Gertler, 2003).

The origin of the concept lies in two main bodies of theory and research. The first body of literature is systems of innovation. Built on evolutionary theories of economic and technological change, the systems of innovation literature conceptualizes innovation as an evolutionary and social process (Edquist, 2004). Innovation is stimulated and influenced by many actors and factors, both internal and external to the firm (Dosi 1988). The social aspect of innovation refers to the collective learning process between several departments of a company (for example R&D production, marketing, commercialization, etc.) as well as to external collaborations with other firms, knowledge providers, finances, training, etc. (Cooke *et al.* 2000).

The second body of literature is regional science and its focus on explaining the socio-institutional environment where innovation emerges. From a regional point of view, innovation is localized and a locally embedded, not placeless, process (Storper, 1997; Malmberg and Maskell, 1997). Accordingly, the literature on regional science deals both with the role of proximity, i.e., the benefits deriving from localization advantages and spatial concentration, and

the territorially prevailing sets of rules, conventions and norms through which the process of knowledge creation and dissemination occurs (Kirat and Lung, 1999). In other words, a regional innovation system is characterized by co-operation in innovation activity between firms and knowledge creating and diffusing organizations, such as universities, training organizations, R&D institutes, technology transfer agencies, and so forth, and the innovation-supportive culture that enables both firms and systems to evolve over time.

The concept of regional innovation systems has emerged at a time of a policy focus toward systemic promotion of localized learning processes to secure competitive advantage of regions (Asheim and Gertler, 2004). The main justification for developing specific targeted policy measures within the regional innovation system framework is to concentrate on improving capabilities and performance in local firms, as well as improving their business environment. From this standpoint, it is of considerable importance to promote interactions between different innovative actors that (should) have good reasons to interact, such as interactions between firms and universities or research institutes, or between small start-up firms and larger (customer) firms (Cooke, 2001). These interactions may embody localized interactive learning but also include the wider business community and governance structure. Accordingly, policy strategies could be oriented towards the promotion of accessibility in the development of a regional innovation system (Andersson and Karlsson, 2002) and the development of local comparative advantages linked to specific local resources (Maillat and Kébir, 2001).

2.2 The region as a locus of innovation

The conception of innovation as a partly territorial phenomenon is to a great extent based on the ‘success stories’ of some specialised industrial agglomerations or regionally concentrated networks of SMEs and industrial clusters (Asheim and Gertler, 2004). There is also growing empirical evidence that, in many cases, parts of learning process and knowledge transfer are highly localised (Maskell and Malmberg, 1999). It is increasingly recognized that important elements of the process of innovation become regionalized. The theoretical discourses on regional development highlight a number of key features.

Firstly, innovation occurs in an institutional, political and social context. Region is the site of economic interaction and innovation (Storper, 1997), or the “mode” for regional innovation systems (Doloreux, 2002a). These arguments are premised on innovation as being fundamentally a geographical process and innovation capabilities as being sustained through regional communities that share common knowledge bases (Maskell and Malmberg, 1999; Asheim and Isaksen, 1997). The increased focus on regions as the best geographical scale for an innovation-based learning economy points to the importance of specific and regional

resources in stimulating the innovation capability and competitiveness of firms. For example, Porter argues (1998) that the enduring competitive advantage in a global economy is often heavily local, arising from a concentration of highly specialized skills and knowledge, [formal] institutions, related business and customers in a particular region. Earlier research on regional innovation system supported this argument and showed that the innovative activity of firms to a large degree is based on localized resources such as a specialized labor market and labor force, subcontractor and supplier systems, local learning processes and spillover effects, local traditions for co-operations and entrepreneurial attitude, supporting agencies and organizations and the presence of customers and users (Asheim *et al.*, 2003; Tödtling and Kaufmann, 2001; Cooke *et al.*, 2000).

Secondly, innovation can be thought of as embedded in social relationships. These social relationships develop over time in along culturally determined lines. The regional context prevails the set of rules, conventions and norms that prescribe behavioral roles and shape expectations (Johnson, 1992). These rules are derived from economic and socio-cultural factors such as routines, shared values, norms and trust that facilitate localized interactions and mutual understanding in the process of transmitting information and exchanging knowledge (Lorenzen, 1998). Thus, as Camagni (1991: 8) points out, ‘the set, or the complex network, of mainly informal social relationships on a limited geographical area, often determining a specific image and specific internal representation and sense of belonging, which enhances the local innovative capability through synergic and collective learning processes’. The strength of the local learning system depends greatly on an array of intangible assets. These include the internal dynamic of the regional, socio-cultural, and political assets; the informal flow of knowledge between different parties generating the bulk of territorialized externalities; and the opportunities for the region to build and keep its distinctive competence (Storper, 1997). Thus, the development of these intangible assets is becoming crucial in building regional innovation capability and strengthening learning capacities (Landry *et al.*, 2002). To some extent these assets could be seen as a specific form of capital that is derived from social relations, norms, values and interaction within a community. The existence of social capital, and trust as an element of social capital, helps to overcome market failures or reduce market costs for firms in densely related networks, by supporting stable and reciprocal exchange relationships among them (Wolfe, 2002).

Thirdly, innovation can occur more easily with proximity though knowledge intensity, regardless of geographical concentration, has been said to be a crucial dimension in such processes (Arundel and Geuna 2004). A regional cluster is defined as a ‘group of firms in the same industry, or in closely related industries that are in close geographical proximity to each other is meant to include geographically concentrated industries included so-called ‘industrial

districts' (Enright, 1998: 337). Clusters also include public institutions, including government education institutions, and support services, with cluster boundaries defined by linkages and complementary across institutions and industries (Porter, 1998). Clusters have in common specialization, proximity, and cooperation that lead to spillovers and synergy within a regional innovation system. Innovation activities benefit from the concentration of economic activities of similar and related firms in a cluster and facilitate knowledge spillovers and stimulate various forms of adaptation, learning and innovation (Feldman, 1994; Malmberg, 1997). As Malmberg and Maskell (2002: 433) point out, 'in such environment, chances are greater that an individual firm will get in touch with actors that have developed or been early adapters of new technology. The flow of industry-related information and knowledge is generally more abundant, to the advantage of all firms involved'. According to these authors, the general argument is that a local industrial structure with many firms competing in the same industry or collaborating across related industries tends to trigger processes which create not only dynamism and flexibility in general, but also learning and innovation.

Much of our understanding of the region as a locus of innovation comes from research on those places that qualify as 'learning regions', 'innovative milieus', 'clusters', 'industrial districts', or 'regional innovation systems'. Although these studies provide clues to understanding regional development and what are considered ideal institutional environments to promote a learning based economy, one must also take into account the fact that these studies are by no means conclusive and largely based on a few 'successful' regions (Cooke and Morgan 1998). Thus far, the research has mainly directed attention to 'localized' processes of learning and knowledge accumulation as a source of regional competitiveness. Therefore, many questions remain open concerning how the process of innovation takes place in space, and how technological change takes place in processes that are tightly – or loosely – spatially bound.

2.3 From an ideal-model to the real world, and back

In the last decade the concept of regional innovation systems has become increasingly popular among economic geographers, regional studies scholars, and regional development policy makers (Doloreux, 2004; Asheim *et al.*, 2003; Wolfe, 2003; Asheim and Isaksen, 2002; Acs, 2001; Cooke *et al.*, 2000; Braczyk *et al.*, 1998; de la Mothe and Paquet, 1998). The popularity of this approach reflects the importance attached to the role of learning and social milieu in social development and economic growth. The approach is popular in part because it provides a narrative on the intangible dimension of local economic development and the processes of knowledge circulation and learning at the seemingly more manageable regional scale. A simple rationale for the widespread adoption of this approach may be that, from a

policy perspective, it is much easier to manage economic policy at a regional rather than a global scale.

A fair number of studies have been undertaken to identify, characterize and sometimes explain the source and evolution of regional innovation systems. A complete elaboration of regional innovation systems studies and the different methodologies¹ used to study them is beyond the scope of the present paper. A sense of some different national and regional studies can be useful to illuminate the nature and dynamics of regional innovation systems and its application, however.

Two main sets of studies seem to apply a framework of analysis based on the concept of regional innovation systems. The first set is based on comparative empirical studies of various regions to explore desirable criteria upon which systemic innovation at the regional scale might occur. Comparative analyses of regional innovation systems are aimed at articulating generalities as well as particularities of specific regions, analyzing new development trends and the resulting policy implications. According to Staber (2001) and Doloreux (2002a), it is difficult to fully understand and capture the degree of application of the regional innovation system approach, and subsequently its potential impact on regional and industrial development in different regions without such comparison. Nevertheless, comparative case study methods allow for a more thorough investigation with respect to the normally hidden variables – the observation of a phenomenon in one case can raise questions as to why it does not occur in another.

Some selected examples of regional innovation systems comparative studies are listed in Table 1. The main objective of these studies is to understand how regional innovation systems function and to specify desirable factors and mechanisms for promoting competitiveness and innovation and assess the implications for policy. These studies provide a state of the art review with respect to conceptual clarification and application vis-à-vis regional innovation systems, in particular focusing on the impact of different types of regional innovation systems in different countries.

The second set of studies offers ‘snapshots’ of individual regional innovation systems by assessing them to determine the extent to which they correspond to a truly regional innovation system. The study of an individual regional innovation system provides important insights into the nature and dynamics of regional development. Such studies can identify the main factors responsible for the emergence and sustenance of a regional innovation system, the social and institutional dynamics supporting innovation activity at a regional scale, and the mapping of

¹ For a more complete description of the different methodologies used by analysts to study regional clusters, see Wolfe (2003).

various kinds of interactions among different actors and factors inside the region (Benner, 2003; Cumbers *et al.*, 2003; Isaksen, 2003; Diez, 2002; Edquist *et al.*, 2002; Freel, 2002; Gertler *et al.*, 2001; Cooke *et al.*, 2002, 2000). The detailed snapshot case studies illustrate the unique characteristics of the institutional context and policy initiatives, and thus the context specificity of each case to lead us to conclude there is no single model to generalize the dynamics of successful regional innovation systems.

Table 1 Some selected examples of regional innovation systems comparative studies

Study (Authors)	Study regions	Objectives	Main results/Lessons
Regional innovation systems: designing for the future (REGIS) (Cooke <i>et al.</i> , 2000)	11 regions in the EU and in Eastern and Central Europe (Baden-Württemberg, Wallonia, Brabant, Tampere, Centro, Féjer, Lower Silesia, Basque country, Friuli, Styria, Wales)	Explore theoretically the key organization and institutional dimensions providing regional innovation system	Highly-detailed of different regions in terms of innovation performance potential for strong and weak regions
European Regional Innovation Survey (ERIS) (Sternberg, 2000)	11 European regions (Vienna, Stockholm, Barcelona, Alsace, Baden, Lower Saxony, Gironde, south Holland, Saxony, slovenia, south Wales)	Study the qualitative and quantitative assessment of determinants for innovation potential of any region as well as the innovative linkages and networks between different players.	Innovation activities and business innovation process can be viewed as a network process, in which business and interaction with other partners play a significant part.
SME policy and the regional dimension of innovation (SMEPOL) (Asheim <i>et al.</i> , 2003; Tödling and Kaufmann, 2001)	9 European regions (Northern Norway, South-eastern Norway, Upper Austria, Triangle region, Lombardy, Limburg, Wallonia, Valencia, Herfordshire)	Investigate how SMEs innovate and to what extent they are relying on other firms and organization in their innovation activities	Innovation activities of SMEs mainly related to incremental innovation and defensive strategy; Interactions are mainly with customers and suppliers; and innovation links of SMEs are more confined to the region
Nordic SMEs and regional innovation systems (Asheim <i>et al.</i> , 2003)	13 Nordic regions (Oslo, Stockholm, Helsinki, Gothenburg, Malmö/Lund, Aalborg, Stavanger, Linköping, Jyväskylä, Horten, Jaeren, Salling, Icelandic regions)	Explore the existence of similarities and differences between regional clusters of SMEs in different regions in the Nordic countries	In a Nordic cluster context, especially initiatives on social networking arrangements have proven to be a successful way to boost and secure social capital and trust. In addition, SMEs that mainly draw on a analytical knowledge base and innovate through science driven R&D (e.g. in biotech) tend to collaborate with global partners in search for new and unique knowledge. SMEs that mainly draw on a synthetic knowledge base and innovate through engineering based user-producer learning tend to collaborate more with regional partners.
Regional clusters-driven innovation in Canada ² (Wolfe, 2003; Holbrook and Wolfe, 2002)	9 regional case study cluster (<i>biomedical</i> : Toronto, Montreal, Vancouver, Calgary; <i>multimedia</i> : Toronto, Montreal, Vancouver; <i>culture industries</i> : Toronto, Montreal, Vancouver; <i>photonics and wireless</i> : Ottawa, Waterloo, Calgary, Quebec; <i>ICT</i> : Ottawa, Atlantic regions; <i>wood products</i> : Kelowna, Quebec, Atlantic Canada; <i>food and beverage</i> : Toronto, Okanagan, Quebec, Atlantic Canada; <i>automobile and steel</i> : southern Ontario; <i>metal products</i> : Beauce)	Identify the presence of significant concentrations of firms in the local economy and understand the process by which these regional-industrial concentrations of economic activity are managing in transition to more knowledge-intensive forms of production	There are two main types of 'emerging' models of clusters: (1) the regional embedded and anchored regions where local knowledge/science base represents a major generator of new ,unique knowledge assets; (2) the 'entrepôt' regions where much of the knowledge base required for innovation and production is acquired through straightforward market transactions, often from non-local sources
Regional innovative clusters (OECD, 2001)	10 European regional clusters in Europe: ICT regional clusters in Finland, Ireland, Denmark, Spain, Flanders, and The Netherlands; mature regional clusters: agro-food cluster (Norway) and construction cluster (Denmark, The Netherlands, Switzerland).	Question the relevance of regional clusters in innovation policy	Regional clusters in every country/region has a unique clusters blends; regional clusters are variation and selection environments that are inherently different; regional clusters may transcend geographical levels

² This research is in progress. The final results are expected in 2005.

A fundamental problem in all types of studies of regional innovation systems is that we cannot, as yet, determine what a regional innovation system would look like in reality (Markusen 1999). For instance, how much, and what type of innovation must occur within a region for it to be a regional innovation system? Do all regions that aspire to take a lead in organizing and innovating become regional innovation systems by default? If there is something like a regional innovation system, the existing literature on the subject is not clear about it.

However, it is also needs to be emphasised that the regional innovation systems approach is continuously further qualified on the basis of empirical investigation. Two main lines of development can be distinguished. Firstly, the regional innovation systems approach explores aspect of regional innovation capabilities in order to get through a detailed analysis of the main elements characterising regional innovation systems. It examines some elements that characterize the main institutional actors, the firms which compose the system as well as others institutional actors. It also stresses the main innovative profile of the region by characterizing the innovation performance with indicators such as education, regional R&D intensities and technological bases, technological outputs - like patents for example. Another objective is to explain regional differences in terms of innovation activities and regional competitiveness. This kind of studies is particularly used by local and governmental authorities; defining what characterizes a region and the components that could make the region an innovative system (Conseil de la science et de la technologie, 2001; RITTS, 2001; Regional Innovation Strategies, 2001; Capron and Cincera, 1998).

Secondly, the regional innovation approach evolves around the fact that one can expect to find regional innovation system everywhere. The regional innovation system is identified by a selection of key indicators on various aspects of organizational and infrastructural capacity, competence, and capability in regions with regard to innovation capability. The main process elements in capturing different innovation potential such as the structural elements of regional innovation systems and the interactions among them (Cooke *et al.*, 1998) are explored. Conceptualization of regional innovation system corresponds to the one found in Cooke *et al.* (2000) and several others (Asheim and Isaksen, 2002; Wolfe, 2003; Tödting and Kaufmann, 2001; Enright, 2001). According to them, all regions have some kind of regional innovation system, including not only regions with strong preconditions to innovation, but also old industrial regions (Kaufmann and Tödting, 2000), peripheral regions (Doloreux, 2003), rural regions (Wigg, 1998) and regions in transition (Quévit and van Doren, 2001). These authors locate regional innovation system at different points on a scale of strong to weak (Cooke, 2001; Cooke *et al.*, 1998) and distinguish between different types of regional innovation systems in order to capture some conceptual variety and empirical richness in this phenomenon (Asheim and Isaksen, 2002).

2.4 Unit(s) of Analysis in Studies of Regional Innovation Systems

The debate on the appropriate scale to study regional innovation systems is far from resolved. Some researchers focus on the city as the key site of innovation processes. Crevoisier and Camagni (2001) and Simmie (2001), for example, argue that cities generate innovation because they act as arenas for the confluence of innovative factors:

[Cities] constitute an organization where the local agents interact and exchange goods, service and know-how, following specific rules. They contain material as well as non-tangible elements. They change continuously as a result of the effect of the learning process and the acquisition of innovative know-how, of its actor, cooperation and new networks between them, and of the strategies and actions of each of them (Barquero, 2001: 225)

A similar argument is made for metropolitan regions as sites of innovation systems (Diez, 2002; 2000). Some research on metropolitan innovation system has concluded that metropolitan areas are the most important location for innovation (Audretsch and Feldmann, 1999) or that they have high innovation potential (Browner *et al.*, 1999) because they offer firms spatial, technological and institutional proximity and specific resources.

Another unit of analysis is ‘the local’ which often refers to districts within cities or metropolitan areas (Asheim and Isaksen, 2002; Saxenian, 1994; Porter, 1998; Enright, 2001). Examples include the Garment district in New York (Rantisi, 2002), the software industry in Oslo (Isaksen, 2003), the electronic cluster in Toronto (Britton, 2003) as well as the media industry in Montreal (Tremblay *et al.*, 2002) and the service industry in London (Keeble and Nachum, 2002).

A more aggregate unit of analysis is “NUTS II” (Evangelista *et al.*, 2002, 2001). The NUTS II classification is the nomenclature of territorial units developed by Eurostat. The use of this classification for regional analysis is not simple and presents an important limit which has to do with the choice of geographical unit of analysis. The regions defined within NUTS II are not necessarily corresponding to sufficiently homogenous and self-contained regions in a broad sense. This unit of analysis is particularly reflected in the studies using the Community Innovation Survey data to identify regional innovation systems and regional patterns of innovation (for example, Evangelista *et al.*, 2002 (Italy); Doloreux, 2002b (Sweden); Simmie, 2003 (UK).

At an even more aggregate level, a supra-regional / sub-national scale is used. This is the case in the studies on Canadian provinces of Ontario (Gertler and Wolfe, 1998) and Québec (Latouche,

1998) and in Belgium with the province of Wallonia (Capron and Cincera, 1999). The main focus of these studies is on the understanding of the role institutions and policy in sustaining innovativeness and competitiveness. The rationale for adopting this unit of analysis is that supra-regional level such as the provinces Ontario or Québec are constituted by specific institutional structures and cultural traditions that facilitate and regulate economic behavior and social activity (Wolfe and Gertler, 1998). Hence, the innovative efforts of this territorial unit, at least in Canada, (could) display (some of) the characteristics of a regional innovative system.

The diversity of the units of analysis employed in studies of regional innovation systems presents a major problem in developing a unified conceptual framework towards a construct of 'the region' as a theoretical object of study. As a result, this prompts renewed confusion vis-à-vis not only the application and assessment of innovation system at the 'regional' level (whatever defined), but also its territorial boundaries.

3. HIDING BEHIND THE WALL: PERSISTING INCONSISTENCIES OF REGIONAL INNOVATION SYSTEM LITERATURE

3.1 Definition confusion and empirical validation

According to Cooke and Morgan (1998), a strict reading of the literature would suggest that only three regions are true regional innovation systems: Silicon Valley, Emilia-Romagna, and Baden-Württemberg. However, the variety of regional innovation systems provides a problem of definition and empirical validation. If the concept of regional innovation system is widely accepted in its specific form, and used to derive strategies and policies, the basis for the definition and existence remains obscure; at least the literature is not clear in what way a specific region can be labelled as an innovation system.

The issue of the empirical representation of regional systems is one of the most discussed in the field of research. This new form of territorial organization which has been described by Markusen (1999; 2003) as ‘fuzzy’, and whose policy relevance has been called into question (Staber and Morrison, 2000), is neither clear nor readily operational. The regional innovation system approach explicitly recognizes the institutional nature of the innovation process and the key elements which influence a firm’s capability to innovate.

Arguably all regions, however defined, have some kind of innovation system. The shortcoming of the regional innovation systems approach is perhaps best captured by its inability to address the fundamental question of how one ‘knows’ a regional innovation system when one sees one (Markusen 1999). Most analyses can be criticized for failing to adhere to a unified conceptual framework and clear definition or conceptualization of such key terms as region, innovation system, and institutions. Certainly, notable efforts have been made in this direction by Asheim and Isaksen (1997) and Cooke *et al.* (1998) who describe a regional innovation system as one that comprises a ‘production structure’ embedded in an ‘institutional structure’ in which firms and other organizations are systematically engaged in interactive learning. This description captures the complexity of the integrated whole that is a regional innovation system without sufficiently revealing what constitutes the production structure, the institutional structure, the region, the actors, and the interactions and inter-relations that bind them together.

The precise distinction between the scales of innovation systems is indeed difficult to ascertain. Perhaps because of this difficulty some authors point to variations within the regional scale (Asheim and Isaksen, 2002; Cooke *et al.*, 2000) while others see regional innovation system as a subset of a national system (Wiig, 1999; Archibugi and Michie, 1997). Notwithstanding the

difficulty of ascribing scales to innovation systems, the bulk of the literature reviewed for this paper fails to define or elaborate on key terms and concepts. Given the policy makers' interest in the idea of regional innovation systems and the eagerness of regional innovation system researchers to conclude their studies with policy recommendations, there is an urgency to bring some clarity into the discourse: What do we mean by a region? What are the scales of innovation and how do they correspond with the regional scale? What are institutions? What are the linkages between institutions and a regional system of innovation?

3.2 Regions and scales of innovation systems

3.2.1 What is a region?

According to Niosi (2000) any definition of regional innovation system should start by defining regions. The regional innovation system approach embraces numerous scales and utilizes an array of units of analysis. In addition, the literature is ambiguous on the nature and characteristics of the oft-mentioned institutional context. Within the regional innovation approach, the term 'region' has been variously applied to territories and jurisdictions as different as the country of Denmark (Maskell 1998) the Canadian provinces of Ontario (Wolfe and Gertler, 1998) and Quebec (Latouche 1998), diverse cities (Simmie, 2001), and small-scale industrial districts below the urban level of aggregation (Asheim and Isaksen 2002), as well as areas like NUTS II regions that do not necessarily correspond to any single jurisdiction (Evangelista *et al.*, 2002). The 'region' has increasingly become an economic policy focus in Europe and elsewhere while 'institutions' are said to be crucial to the existence and sustenance of regional innovation systems. These terms require some clarification.

Cooke (2001) and Cooke and Schienstock (2000) have proposed two distinct definitions of a region. In the first definition, a region is described as a geographically-defined, administratively-supported arrangement of innovative networks and institutions that interact heavily with innovative outputs of regional firms on a regular basis. In the second definition emphasis is placed on the 'georegional' or cultural aspects of the region. In this sense a region need not have a determinate size, it is homogenous in terms of specific criteria; it can be distinguished from bordering areas by a particular kind of association or related features; and it possesses some kind of internal cohesion. The type of definition adopted can heavily influence the strengths or weaknesses of specific aspects of regional competitiveness, and thus often makes it impossible to draw comparisons from them. As a cultural entity, the meaning of region is better captured through the concept of embeddedness, which captures the institutional context and underlines the systemic interconnectedness and interdependency of the region.

3.2.2 *The boundary of the regional innovation system*

Questions have lately been raised over the need to address the role of extra-regional networks and institutions as mechanisms of knowledge generation and circulation in addition to processes (and institutions) within regional innovation systems. (Doloreux, 2004; Hommen and Doloreux, 2004 ; Cumbers *et al.*, 2003 ; Mackinnon *et al.*, 2002; Bunnell and Coe, 2001). These questions arise from the fact that successful regional innovation systems make use of endogenously generated and exogenously available knowledge to strengthen competencies and maintain competitiveness.

As Asheim and Gertler (2004) point out:

Regional innovation systems are not sufficient on their own to remain competitive in a globalizing economy. Production systems seem to be more important innovation system at the regional level. Thus local firms must also have access to national and supra national innovation systems, as well as to corporate innovation systems from the local firms that have been brought . This line of reasoning is followed to a point where the regional innovation system expands beyond its own boundaries through a process of economic integration and globalization .

Archibugi and Michie (1997) concur:

To understand technological change it is crucial to identify the economic, social, political and geographical context in which innovation is generated and disseminated. This space may be local, national or global. Or, more likely, it will involve a complex and evolving integration at different levels of local, national and global forces.

Hommen and Doloreux (2004) conclude:

To develop a more comprehensive approach to understanding RIS, it will be necessary to consider failures as well as successes, non-localized as well as localized learning, and different modes of integration, both locally and globally. One possible line of inquiry might centre on the precise nature and the relative importance of localized and non-localized learning, relating these to the forms of knowledge accumulation that sustain the globalization of firms and the competitiveness of regions. On this basis, it would be possible to develop a more discriminating account of the conditions that enable some regions to adapt and generate certain forms of knowledge, more successfully than others.

Innovative firms are linked to the outside world by various sorts of connections, in particular, international linkages with customers and suppliers, as a key requirement for successful

innovation development. What seems to mark out the more successful innovative firms is the ability to connect and to tap into different innovation systems as a source of competitive advantage: being plugged into wider networks provides a variety of knowledge sources that not only generate inputs for firms, but also sustain their economic activity. This statement is reinforced in recent studies on innovation and collaborations in different regional clusters (Cumbers et al., 2003 [Aberdeen oil complex]); (Doloreux, 2004 [Ottawa and Beauce regions in Canada]); (Wolfe, 2003 [various Canadian regions]), (Henry and Pitch, 2002 [Motor sport industry in UK]).

Recent contributions by Bathelt *et al.* (2002), Malecki and Oinas (1999), Henry and Pitch (2002) and others have pointed out the importance of local interaction and global connections for understanding competitive advantages of innovative firms and regional clusters. This line of reasoning is followed to a point where a regional system expands its own boundaries through a process of economic integration and globalization. Building on this stream of literature, Bathelt *et al.* (2002) maintain that an accurate model of cluster must take into account two types of knowledge flow i.e. the local channels and the global ones respectively. According to them, the co-location within a cluster will stimulate the development of a particular institutional structure shared by those who participate (local buzz), whereas the extra-local knowledge flows (through the pipeline system) will support a cluster's cohesion and strength by being more globally-connected instead of being more inward-looking and insular in its development. Bathelt *et al.* (2002) further argue that local buzz and global pipelines are mutually reinforcing:

The more firms of a cluster engage in the build-up of trans-local networks, the more information and news about markets and technologies are pumped into internal networks, and the more dynamic the buzz from which local actors benefit.

A more general concern with regard to regional systems relates to the mostly casual use of the term "institutions" or the institutional environment as features which allow regional innovation systems to tap into, acquire, and disseminate knowledge to strengthen current or generate new competencies. The lack of attention to the central role of institutions may be explained through an observation by Freel (2002) who asserts that discussions of innovation systems framed purely in terms of institutions are likely to tend towards excessive ambiguity. We agree that there is a danger of getting "lost in the woods" while searching for the institutional component. This, however, does not make the necessity of attending to the role of institutions in the emergence and sustenance of regional innovation systems any less urgent.

3.3 Accounting for the role of institutions

Institutions are “social relations” that frame the activities of production, consumption, and exchange (Setterfield 1993:756); the substance rather than merely the boundaries of social life (Hodgson 1988:134); and the guide to reduce uncertainty in human interactions (North 1990:3-4). As such, institutions operate at and through different arenas that may be grouped into levels of inter-relation, scales of governance, and systems. Thus understanding institutions requires appreciation of complexity, continuity, and evolution in historical time. The task requires carefully organized categories that reveal the levels, scales, and systems around and through which institutions are woven. Institutions are context-specific and collectively act as an integrated web running through different *systems* (e.g., social, economic), *scales* of governance (e.g., local, regional, national), and *levels* of inter-relation (e.g., among individuals, organizations, societies). Context specificity may also manifest itself as path dependency, cumulative causation, and lock-in (Hodgson 1994). Three additional elements may be added to this mix.

First, long-term institutional change is path dependent and derived from the economy’s specific adjustment path toward certain institutions (Setterfield 1993, Hodgson 1999a). Second, institutional evolution is shaped by the feedback process by which human beings perceive and react to changes in their environment, through what North (1993) calls ‘shared mental models’. Third, institutional evolution is the product of the symbiotic relationship between institutions and organizations (North 1990:7) in a process best described as a continuum and denoted as ‘cause-effect-cause’. We may also add that institutions are at once persistent, resistant to change, but capable of changing in evolutionary time, and transmitted through various means to consecutive generations to provide a certain degree of continuity, stability, predictability, and security. Because institutions are manifest in all spheres of socio-economic life, and by most accounts play important roles in facilitating and curtailing change, there is a need for meaningful categorization so as to make the analysis of institutions possible where they are manifest and not as a grey box appearing in schematics of socio-economic change.³

Given the ‘key variable’ status of institutions in most analyses of regional innovation systems it is crucial that the properties of the variable, and the role(s) expected of it, are defined and articulated. Institutions are made up of symbolic elements, social activities, and material resources (Scott 2001) to define the structure for interactions among humans based on rules, norms, and values. Institutions may appear as organizations, cultural phenomena, or structures sharing important commonalities. All institutions may be viewed variously as production systems, enabling structures, social programmes, or performance scripts depicting stable designs

³ For details of a methodology for institutional analysis see Parto (2003a, 2003b).

for chronically repeated activity sequences (Jepperson 1991:144-5). As such, institutions are produced, modified, and/or reproduced by human behaviour (Scott 2001). The ‘permanency’ or durability of institutions is only relative as institutions continuously undergo change due to societal dynamics and entropy, or a tendency toward disorder or disorganization (Zucker 1988:26) and a subsequent reorganization to produce new or modified institutions.

Institutions may be grouped into five ‘types’.⁴ First, institution may be “associative”, in that they comprise socio-political structures characterized by exclusion, socialization, controlling conditions of incumbency, and hero worship to express certain values or interests. Associative institutions are reproduced by succeeding generations of power holders to exercise a degree of selectivity (Stinchcombe, 1968). Second, institutions may be “behavioural” in that they are transmitted by various carriers, including symbolic and relational systems, routines, and artefacts (Durkheim, 1950; Mitchell, 1950; Neale, 1994). Third, institutions may be “cognitive” in that they are based on values and embedded in culture (Neale, 1987; Scott, 2001). Fourth, institutions may be “regulative” in that they provide stability and give meaning to social life (Thelen and Steinmo, 1992; Tool, 1993). Fifth, institutions may be “constitutive” in that they are social structures that have attained a high degree of resilience and operate at multiple scales of jurisdiction (North, 1990; Scott, 2001).

Accounting for institutions requires specification of the level(s), scales(s), and system(s) at and through which a regional system of innovation is being studied. More generally, phenomena at the national scale of governance occur in relation to factors at higher and lower scales. Institutional analysis of a national phenomenon would *recognize* but not necessarily conduct in-depth analysis of the local or continental scales. Taking a multi-level, multi-system, and multi-scale perspective on institutions as suggested here increases the need for the articulation of the research question and of the analytical approach adopted. Articulation and specification enable us to go beyond merely describing institutions collectively as an important factor to consider. This articulation further allows research to focus on the key institutions in a given situation and avoids “analysis-paralysis” that may result from being overly concerned with the importance of complexity and the need to remain holistic.

To sum up, when we speak of something as being ‘instituted’ we at once allude to something that has been “learned” and adopted by individuals, singly or in groups, which affects inter-relations at all levels; something by which individuals or groups of individuals may be characterized at different scales; and perhaps most importantly, something that reveals a degree of relative permanency as manifested in habits, customs, and so forth within or across systems. Depending on the purpose of the analysis some levels, scales, or systems need to be more, or

⁴ See Parto (2003a) for further details of this typology.

less, emphasized than others since not everything is equally important in all situations and all the time.

5. CONCLUDING REMARKS

The regional innovation system is a normative and descriptive approach that aims to capture how technological development takes place within a territory. The approach has been widely adopted to underline the importance of regions as modes of economic and technological organization, and to reflect on the policies and measures aimed at increasing the innovative capacity of all kinds of regions.

It is generally conceded that the innovative performance of regions is improved when firms are encouraged to become better innovators by interacting both with various support organizations and firms within their region. In this sense, the institutional characteristics of the region, its knowledge infrastructures and knowledge transfer systems, as well the individual strategy and performance of firms, can represent important basic conditions and stimuli in promoting innovation activities.

However, the diverse variety of regional innovation system types creates a significant degree of 'definition confusion' and empirical validation issues, making it difficult for researchers and policy makers alike to envisage what a regional innovation system is, or should be. The approach thus suffers from the absence of a unified conceptual framework from which a universal, albeit very broad, model may emerge to guide research and policy.

An emphasis on localized learning and the existence of untraded interdependencies is simply not sufficient for understanding the scale at which regional innovation system can be deemed to function, studied, or 'engineered'. There is far too much emphasis on 'local' institutional landscape without a satisfactory breakdown of what the institutions are or how they interact in different system, at different scales, or at different levels of inter-relation.

Regional institutions and institutional arrangements as factors that generate appropriate forms and practices to enhance regional innovation potential can and, we argue, should be identified and categorized according to levels, scales, and systems. Accounting for institutions in the manner suggested in this paper will require adopting a multi-dimensional perspective that will yield comparable findings from studying a diverse range of regions with important implications for policy development and implementation as well as further research.

In this paper we have presented a systemic account of the weaknesses and potentials of the regional innovation system as a concept, attempting to provide a few potentially fruitful points of departure for future research on this theme. In parallel, with this critical review we wish to

raise some questions about the soundness of a foundation on which a significant proportion of regional policy making is based.

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