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REGIONAL INNOVATION SYSTEMS WITHIN A FEDERATION: DO NATIONAL POLICIES AFFECT ALL REGIONS EQUALLY?

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1. *Introduction*

The ability to innovate is one of the most powerful sources of competitive advantage in modern economies. The ability to acquire, adapt and advance knowledge determines how well businesses and countries innovate and, in turn, how well they compete locally and globally. Technology-based clusters that have achieved a critical mass in the knowledge economy are emerging in some regions. These clusters are anchored by strong research universities, industrial laboratories and entrepreneurial companies, with human capital and infrastructure to match. Collectively these clusters form regional and national systems of innovation.

The literature on national innovation systems (NIS) is quite recent. The first author to introduce the concept was Christopher Freeman in a case study of Japan, in 1987. Bengt-Ake Lundvall (1992) developed the concept from a more theoretical and conceptual point of view, using Denmark as an example. Richard Nelson in 1993 edited a book with 15 studies of NIS. Since then, many books and articles have been written about the concept; but there is still not a "formal or established theory" of NIS, as many researchers point out (see (Edquist, 1997a; Holbrook & Wolfe, 2000; Nelson & Rosenberg, 1993; Salazar, 1994). Nevertheless, theories of interactive learning together with evolutionary theories of technical change have been considered as constituting the origins of the systems of innovation approach (Edquist, 1997b).

Since then the systems of innovation approach has shifting from solely a national perspective to one including regional or local systems. Are NIS singular systems, or are they simply agglomerations of regional innovations systems (RIS)? Is an NIS greater than the sum of its component RIS? This focus on spatial aspects has two major advantages; on the one hand, it recognizes that innovation is a *social process* and is shaped by persons and institutions that share a common language, rules, norms and culture (i.e. common modes of communication). On the other hand, innovation is also a *geographic process***,** taking into account that technological capabilities are grounded on regional communities that share a common knowledge base.

Once we move downward from national to regional innovation systems, however, the institutional framework becomes paradoxically, less clear, at least in terms of government, despite the smaller and apparently more manageable nature of the system. '[R]egions are neither autonomous nor sovereign in terms of relations with the nation-state or supranational institutions. The regional institutional arrangement is linked with elements of super-ordinate governance' (Braczyk & Heidenreich, 1998). Moreover, regional powers of action vary from country to country. Some regions span more than one sub-national unit of government, others are sub-sets within a distinctive regional space, others have virtually no formal or dedicated 'governance' at all (for example, there is no single politico-administrative authority corresponding 'Silicon Valley) while still others have few if any specific policy tools or levers with which to influence innovation processes.

In the present global context, federations, with the combination of shared government and autonomous governments, offer a practical way of putting together the benefits of unity and diversity through representative institutions (Watts, 2001). Additionally, there is a growing recognition among researchers and policy-makers, of the crucial value of a local concentration of assets in a globalized economy. The world economy is currently characterized by a *paradoxical consequence of globalization* in which the ever greater

global integration of national and regional economies which accentuates, rather than minimizes, the significance of the local context for innovative activities (Acs, de la Mothe, & Paquet, 1996); and (D. Wolfe, 2002). (Courchene, 1995) has called this trend or process "*glocalization*".

For federations, the national system of innovation is more complex than that of a unitary system, since there are often provincial/state level institutions and actors that parallel national level institutions and actors, with some policies or powers under provincial control, and others under federal control. Canada is one of the few true economic and social (as well as political) federations in the world. In the OECD, only Australia, the US and Germany[1] come close to the unique structure and socio-economic features that exist in Canada. Consequently, Canada provides a unique laboratory for studies on innovation in regions, RIS, and policies affecting these RIS.

A key element of the Canadian federation is the allocation of most economic powers to the federal government and the devolution of social responsibilities – particularly health and education – to the provinces. In most developed nations innovation, science and technology policies are formulated by the central government, yet most innovation activities take place locally. Thus nation-wide innovation policies may not affect each region equally, and could conceivably be counterproductive in some instances.

Holbrook and Wolfe (2000) have argued that, at least in the case of Canada, in order to understand the NIS, one must first understand the RIS. Is the Canadian NIS the sum of a number of RIS, whether based on economic regions or provincial boundaries? In the Canadian context this summation is distorted by the wide variation in sizes of the regional systems – national level data (and the ensuing analyses) of the Canadian system of innovation are heavily biased by the economic activities occurring in the two major industrialized provinces, Ontario and Quebec, as shown in Table 1.

Table 1. PROVINCIAL INDICATORS 1999

PROVINCE	POPULATION	PGDP	GERD	GERD/PGDP	GERD/Capita
	000's	($M)	($M)	(%)	($)
Newfoundland	541	12110	125	1.0	231
Prince Edward Island	137	2994	26	0.9	190
Nova Scotia	939	22407	343	1.5	365
New Brunswick	754	18390	162	0.9	215
Québec	7347	204062	4822	2.4	656
Ontario	11501	396775	7941	2.0	690
Manitoba	1141	30995	370	1.2	324
Saskatchewan	1026	30143	317	1.1	309
Alberta	2952	116990	1097	0.9	372
British Columbia	4024	118783	1224	1.0	304
Canada	30462	957911	17243	1.8	566

Source: Statistics Canada, 2002

[1] The literature on federations and innovations is not extensive. There is an interesting and recent paper on the German case, analysing the co-ordination between federal and lander governments in respect of innovation policy. See Wilson and Souitaris, 2002.

Notes: PGDG: Provincial Gross Domestic Product; GERD: Gross Expenditure on Research and Development

This paper is an initial result of research being carried out through the Innovation Systems Research Network (ISRN)[2]. The ISRN cluster project results should contribute to the development of a theoretical insight on RIS and clusters. It is hoped it will lead to a better understanding of the following questions:

- For NIS in general, is the whole larger than the sum of its RIS parts?
- In the Canadian federation, is the NIS larger that the simple sum of the regional/provincial innovation systems?
- What is the impact of federal innovation, science and technology policies on regional innovation systems and cluster formation?
- What is the impact of intergovernmental processes, structures and institutions regarding science, technology and innovation policies?
- What are the principal characteristics that contribute to the creation of a national or federal system of innovation or several RIS, based on the development of clusters, using Canada as a case study?
- What is the impact of globalization in the Canadian innovation system (eg. NAFTA, WTO rulings) and the need to make provinces more competitive in specific regions (such as the Asia-Pacific region for BC)?

The purpose of this discussion is to test the proposition that the Canadian NIS is greater than the sum of its component RIS. If this is so, then the process of transferring federal innovation resources into the regions should stimulate additional innovation activity and investment in each region. In the following section we will present briefly the main issues regarding science, technology and innovation policy in Canada. In the third section a short theoretical discussion is presented, which will give us the foundations for proposing a classification of Canadian RIS in the next section.

[2] In 2001 the Innovation Systems Research Network (ISRN), funded by the Social Sciences and Humanities Research Council of Canada, launched the project "*Innovation Systems and Economic Development: The Role of Local and Regional Clusters in Canada"*, that will examine the impact and importance of cluster-driven innovation in Canada. The underlying policy objective is to understand regional differences innovation. The ISRN project is using cluster studies to provide data on RIS.

2. *The Canadian Federation: its science, technology and innovation policies*

It has often been stated "Canada now stands alone as the only major industrial country without a "central" advisory and reflection-orientated body" (Latouche, 1998). With the closure of the Science Council of Canada in the early 1990s this is technically true although there is a Prime Minister's Advisory Council on S&T, established in 1996, which provides with expert, non-partisan advice on national S&T goals and policies and their application to the Canadian economy.

In general, in Canada S&T and innovation policies are developed at the federal level, but education policies are under the provincial realm. Most of the funding for R&D (for firms and academic institutions) comes from federal institutions and programs, which are then implemented at the local level. As Latouche noted:

> "In the absence of a clear-cut division of constitutional responsibilities, the central government has been able to use its 'spending power' (i.e. its ability to spend moneys and set up programmes in any policy area as long as it did not claim to have thus obtained jurisdiction over these fields), to make its presence felt in all areas and this create a sense of Canadian identity and community from coast to coast." (Latouche, 1998)

What is the degree of manoeuvrability of provincial governments to foster innovation in the regions? Some provinces have made a major effort to provide "matching" funds to those federal funds, but how effective have they been in altering development patterns? Have been some of these innovation policies and programs more successful in certain regions, or have they been equally successful across the country? Are these successes or failures predictable on the basis of the structure of the policies and programs?

Table 2. FEDERAL EXPENDITURES ON SCIENCE AND TECNHOLOGY, BY PROVINCE 1994-95 T0 1999-2000 ($ millions)

PROVINCE	1994-95	1995-96	1996-97	1997-98	1998-99	1999-2000
Newfoundland	93	87	75	67	86	87
Prince Edward Island	21	16	15	12	17	20
Nova Scotia	191	188	186	163	200	192
New Brunswick	79	76	62	60	75	76
Québec	808	764	789	755	788	837
Ontario	1122	1034	1036	1098	1143	1350
Manitoba	172	166	166	136	136	161
Saskatchewan	99	100	87	110	122	131
Alberta	230	237	230	230	254	300
British Columbia	402	366	332	354	446	529
Territories	22	13	16	15	15	20
Canada excluding NCR	3239	3047	2994	3000	3282	3703
National Capital Region (NCR)	1722	1759	1796	1658	1942	1937
Canada including NCR	4961	4806	4790	4658	5224	5640

Source: Statistics Canada, 2002

As Table 2 shows the large proportion of funds allocated to S&T that are spent in Ottawa (the National Capital Region), Ontario and Quebec by the federal government (around 74% the three together), while the other 26% is divided between 8 provinces and the territories.

In most developed nations innovation and science, technology and innovation policies are formulated by the national government, yet most S&T activities take place locally. Local and regional governments have a major influence on the success or failure of national S&T policies and programs, often indirectly, in that local and regional policies and programs, often completely unrelated to S&T activities, establish environments that may assist or hinder the successful outcome of S&T projects. For instance, local building ordinances, local and regional taxes, employment subsidies, and educational policies, all influence S&T activities. Therefore, the design of national and (especially) federal R&D support programs and the location and spending decisions of federal research agencies requires a delicate juggling act between federal interests, provincial sensibilities and business realities. As Latouche says:

> "Ever since the publication (in 1971) of its White Paper on the subject, the Canadian government has been trying to provide Canada with a coherent and well-suited science and technology policy. A major obstacle in the formulation, let alone the implementation, of such policy, has been finding a proper framework to integrate the myriad of federal and provincial initiatives". … (F)ederal authorities have (tried) …… to force (provincial authorities) to adjust their own priorities to the national ones. "Nevertheless, the question remained the same: should Canada have one, five or even ten S&T policies?" (Latouche, 1998)

The fact that provincial government are responsible for higher education has further complicated matters since any major S&T infrastructure decision by the federal government can force the provincial to review their priorities. But the issue at the end of the idea, is who got the money for R&D. "As in most policy areas, budgetary control provides one major tool for governments to coordinate S&T policy." (Hart, 2001)

Governments, both provincial and federal, have at least three roles to play in R&D[3]:

- Setting policies which influence the environment in which R&D occurs;
- Funding R&D which is performed by others (either directly or through tax concessions); and
- Performing R&D themselves in government departments and agencies.

National or federal governments invariably undertake all three roles. But in almost all federations, provincial governments do so also. In Canada, many provinces have science policy councils or advisory committees, and some federal science policy bodies include provincial representation (although this is not strictly true for Canada in that the

[3] The following paragraphs are drawn from notes prepared by John Phillimore and Adam Holbrook, when John Phillimore was on leave at CPROST from Murdoch University in Western Australia. This period provided a fertile period for debate on the similarities and differences between the Canadian and Australian federations.

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provincial governments are not represented – but every effort is made to ensure equitable representation by individuals from across the country). There may also be inter-governmental councils of ministers to discuss common issues (i.e. the Council of Ministers of Health in Canada).

In this sense, Latouche noted that "by definition, regional states are limited in their legislative and policy pretensions. Although they often claim to be in a better position to intervene in many areas, certain responsibilities elude them, having been attributed to another level of government, local, national or even supranational" (Latouche, 1998).

As funders and performers of research, provinces collectively tend to be less significant than the federal government, which normally has greater revenue resources to financially support business R&D (through grants, contracts and tax concessions). Similarly, most countries support academic research through granting systems established and funded by national research councils. But provincial governments are often active, if at a lower level of support, in financially supporting both businesses and universities. Both federal and provincial governments can also be significant performers of R&D through the activities of their own agencies and departments.

Table 3 shows the concentration of federal R&D spending by performer and province. This direct spending can be viewed as a proxy for federal R&D programs and policies, although it does not include federal R&D tax credits to the business sector (these are approximately 20% of total business R&D spending). Federal intramural spending in the National Capital Region is directed towards national objectives, although many of the spin-offs arguably benefit the local and regional economy.

Table 3. FEDERAL EXPENDITURES ON SCIENCE AND TECNHOLOGY, BY PROVINCE AND SECTOR OF PERFORMANCE 1999-2000 ($ millions)

PROVINCE	Intramural federal R&D spending	Total federal R&D spending	Total business R&D spending	Federal R&D spending in business	Total university R&D spending	Direct federal R&D spending in universities
Newfoundland	25	53	18	10	79	15
Prince Edward Island	12	17	3	2	12	2
Nova Scotia	72	120	64	10	210	36
New Brunswick	32	53	40	8	89	10
Quebec	249	671	3027	158	1496	252
Ontario	322	1057	5659	267	2011	360
Manitoba	58	101	146	12	158	28
Saskatchewan	60	102	80	8	176	27
Alberta	108	249	481	25	484	104
British Columbia	106	400	707	142	441	149
Territories	7	8	2	0	0	0
Canada excluding NCR	1051	2831	10228	642	5154	983
National Capital Region	808	808				
Canada including NCR	1859	3639		642		983

Source: Statistics Canada, 2002

The federal R&D issue which is probably of most concern to provincial governments is the distribution of funding and federal facilities across the country. In particular, provincial governments are keen to see that a 'fair share' of national R&D resources is spent in their jurisdiction - preferably, more than their fair share! They are concerned to ensure that federal research laboratories are not unduly concentrated in other jurisdictions, and that university research spending funded by federal granting agencies is equitably distributed.

These concerns are relevant in terms of RIS analysis. The presence of R&D laboratories and universities provide direct employment and expenditure, as well as the potential for spin-offs in terms of industry linkages or attracting inward investment, for regions possessing such resources. The absence of strong public sector research laboratories, conversely, makes developing industries that require key technologies or research strengths and related personnel much more difficult. Past decisions on the location of Federal R&D laboratories can have a powerful 'path dependence' effect. Likewise, attracting new facilities can be a springboard for new initiatives in innovation and industry policy. But this simple intervention is by no means successful: in Canada; federal human biotechnology research centres are in Montreal, Ottawa, Winnipeg, Saskatoon and Halifax, but the commercial biotech clusters are in Toronto, Montreal and Vancouver (Niosi, 2002).

Therefore a key concept for provincial governments is 'leverage'; they aim to use their financial or political resources to retain and attract federal R&D facilities, as well as attempting to help their researchers and industries win a larger share of federal research grants, centres of excellence, etc. This may involve competing aggressively for federal laboratories and private investment through financial inducements or political pressure. Some provincial may subsidise R&D in local firms by establishing support programs that in many respects duplicate or complement federal programs (i.e. Quebec and Ontario tax incentives), in order to give their companies a 'head start' in the competition to win grants. Similar support may be provided for local universities and academic researchers.

The provinces are, naturally enough, concerned to attract as much federal (and private) R&D funding as they can in order to build their regional innovation systems. This may include plans to diversify from their existing technological and industrial base through attracting new R&D facilities. In addition, equity and political considerations are never too far from the surface in provincial arguments about federal funding. These are not (always) self-serving; they can on occasions reflect long-standing grievances and patterns of inequality from regions that consider themselves to have been poorly treated by the federal system.

3. Theoretical discussion

The NIS literature emerged from evolutionary economic theory, joined with more mainstream science, technology and innovation policy analysis[4]. Focus on RIS by contrast, came initially from regional science and economic geography, as well as institutional economists and sociologists (Holbrook & Wolfe, 2000; Wilson & Souitaris, 2002). Regions are often defined in terms of shared normative interest (cultural areas), economic specificity (mono-production systems) and administrative homogeneity (governance areas). To these may be added other criteria, such as a non-specific size (except that of being part of a nation state); identifiable cultural or industrial mix; an ability to be distinguished from other regions in terms of these criteria; and, possession of some combination of internal cohesion characteristics (P. Cooke, 1998).

The OECD has noted that the study of national systems of innovation offers new rationales for government technology policies. Previously national government science and technology policies focused on market failures. Studies of innovation systems can identify systemic failures (OECD, 1997). There is no single accepted definition of an NIS. Two of the most commonly used are:

- An NIS can be defined as the interaction of innovative capabilities of firms with a set of institutions that determine the firm's capacity to innovate. The interrelationship of these institutions is also important, since they do not always work in the same direction and easily together, nor is the system purpose-built. (Nelson & Rosenberg, 1993)[5]

[4] The literature on new technologies and the impact on development emerged almost at the same time as the national innovation system approach, and most of the main authors have published in both topics (i.e. Freeman, Lundvall, Nelson).
[5] For the purposes of this research, we will be using Nelson and Rosenberg definition of an NIS as the "accepted" definition.

- An NIS is "the elements and relationships, which interact in the production, diffusion and use of new and economically useful knowledge (…) and are either located or rooted inside the border of a nation state". (Lundvall, 1992)

Holbrook and Wolfe have summarized the key characteristics of an NIS:

- Firms are part of a network of public and private sector institutions whose activities and interactions initiate, import, modify and diffuse new technologies.
- An NIS consists of linkages (both formal and informal) between institutions.
- An NIS includes flows of intellectual resources between institutions.
- Analysis of NIS emphasizes learning as a key economic resource and that geography and location matters. (Holbrook & Wolfe, 2000)

How then to define the boundaries of a RIS? NIS are clearly defined by their frontiers, and the application of national legislation and public policy (Niosi, 2002) . A couple of views:

- A RIS is a set of economic, political and institutional relationships occurring in a given geographical area, which generates a collective learning process leading to the rapid diffusion of knowledge and best practice (Nauwelaers & Reid, 1995).

- A RIS denotes regional clusters surrounded by supporting organizations (Asheim & Isaksen, 2002).

Going a step forward, one needs to distinguish between an RIS and a regional cluster of the type defined by Porter, among others. How much innovation and what type of innovation should exist in a cluster for it to be considered a viable element of an RIS? Several possibilities exist:

- Clusters are geographic concentrations of interconnected companies and institutions in a particular field (Porter, 1998).

- A cluster is a geographically bounded concentrations of interdependent businesses (Rosenfeld, 1997); cited by (Asheim & Isaksen, 2002).

- Clusters are regarded as places where close inter-firm communication, and social-cultural structures and institutional environment may stimulate socially and territorially embedded collective learning and continuous innovation (Asheim & Isaksen, 2002).

Given that the differences between a RIS and cluster may not be clear, we lean toward the definition of a RIS given by Asheim and Isaksen. For the purposes of this research and the ISRN project the difference between a RIS and a cluster, is that a RIS is a "cluster of clusters". But still we have to define in a pragmatic way what it is considered a RIS in the Canadian context. To define a region is not a trivial issue, especially in the case of Canada, because of its territorial size and concentration of population along the US border. It is important to ask the question: Are the RIS based on the provinces, or metropolitan regions within the provinces, or combinations of these? Niosi makes the argument that for the purposes of defining Canadian RIS, regions will be considered as urban agglomerations. He further argues that the "provinces are far too large for most externalities to occur homogenously across their territories" (Niosi, 2002).

As Holbrook and Wolfe note the "emphasis on the role of institutions is a cornerstone of the systems of innovation approach" (Holbrook & Wolfe, 2000). In this sense, is that the political and governance dimension of innovation, science and technology policy, and therefore of innovation systems, is highly relevant. The emphasis lies in not simply having a list of the actors in the innovation system, but to know how they network together, and the interactions between them.

> "Federations are, by definition, complex systems of governance, in which it is important to have good intergovernmental relations, due to the non-subordination between the federal government and the provinces. Additionally, "within federations the inevitability of overlaps and interdependence in the exercise of their constitutional powers has generally required extensive intergovernmental consultation, cooperation and coordination."(Watts, 2001)

There are many studies on RIS from the perspective of economic geography. In particular, there are studies that establish different typologies of RIS and clusters, with the intention to make explicit the differences that may be found within a country, and the complexities of the study of RIS and clusters. A useful model was developed by Cooke (1998) who established two key dimensions to analyze RIS: the (S&T) governance structure and, the business innovation superstructure[6].

The governance infrastructure dimension – initially developed for technology transfer purposes- establishes three main types of RIS: grassroots, network and dirigiste. It is clear that governance structure for Cooke it is not political governance as it is usually understood. The initiation of the RIS is the key feature, which then affects funding, the type of research (applied, basic, near to the market, etc.), the level of technology specialization and the forms and degrees of coordination. Grassroots are locally organized, network RIS are multilevel organized and dirigiste are the product of central government policies. The business innovation dimension gives us the posture of the firms in the regional economy, both towards each other and the outside world, as well as in relations with producers as with consumers in the market place.

SOME EXAMPLES OF REGIONAL INNOVATION SYSTEMS[7]

Governance structure/ Business innovation dimension	***Grassroots***	***Network***	***Dirigiste***
Localist	Tuscany (northern Italian industrial districts)	Tampere (Denmark)	Tohoku (Japan)
Interactive	Catalonia	Baden-Wutemberg	Québec
Globalized	Ontario California	North Rhine–Westphalia	Singapore Midi-Pyrenées

Source: Cooke, 1998: 22.

[6] Cooke (2002) has more recently laid out more evidence on the regionality of innovation systems using biotechnology as a case study.
[7] These are the cases studied in Braczyk, Cooke and Heidenreich (1998).

From these examples Cooke builds on both dimensions. The following tables were adapted from the explanation he gives to each variable or characteristic that help to differentiate between each RIS.

THE GOVERNANCE DIMENSION

Issue or variable	***Grassroots RIS***	***Network RIS***	***Dirigiste RIS***
Initiation	Locally organized	Multi-level: local, regional, federal and supranational levels	Product of central government policies Animated from outside
Funding	Diffuse Local banking and government, chambers of commerce	Guided by agreement among banks, firms, and government agencies	Largely centrally determined
Research	Highly applied or near market	Mixed: pure and applied research and near market activities	Basic or fundamental
Technical Specialization	Low, generic problem solving	Flexible	High
Coordination	Low degree of supra-local coordination	High Many stakeholders, presence of forums, associations, industry clubs	Very high at least potentially

Source: Based on Cooke, 1998.

THE BUSINESS INNOVATION DIMENSION

Characteristics	*Localist RIS*	*Interactive RIS*	*Globalized RIS*
Domination	Few or no large enterprises or large branches of externally controlled firms Dominated by SME	Balance between large and small firms, whether indigenous or FDI in origin	Global corporations, sometimes clustered supply chains of rather dependent SME
Research reach	Not very great	Access of regional research resources to foreign innovation	Internal
Public vs. private R&D	Few major public innovation or R&D resources, and small private ones	Mixed of public and private research institutes	Private mainly, but could be public research infrastructure to help SME
Associationalism	High degree of association among entrepreneurs and between them with local or regional policy-makers	Higher than average, expressed in local and regional industry networks, forums and clubs	Influenced by larger firms and conducted on their terms

Source: Based on Cooke, 1998.

Why is Cooke's framework useful? Because it highlights economic, political, financial, and governmental issues that affect the creation of various types of RIS. Furthermore the stimulation of innovation in each category demands different policies and programs.

4. Some examples of Canadian RIS

We propose to use Cooke's paradigm, where he outlines the characteristics of RIS governance structure (grassroots/network/dirigiste) and business innovation (localist/interactive/globalized) dimensions to clarify and classify the various provincial innovation systems in Canada.

TYPES OF CANADIAN PROVINCIAL INNOVATION SYSTEMS: A PROPOSAL[8]

Governance structure/ Business innovation dimension	***Grassroots***	***Network***	***Dirigiste***
Localist	Prince Edward Island	Nova Scotia Newfoundland	New Brunswick
Interactive	Saskatchewan Manitoba	British Columbia Alberta	Québec
Globalized	Ontario		

Author's classification based on Cooke's framework.

A first approach from the policy perspective should ask if one innovation policy could fit the economic and social circumstances existing in each of the provinces. It is clear from the table above, that of nine possible cells, Canadian provincial innovation systems fit into seven different cells. The difficulties facing federal policy makers are immediately apparent!

What are the necessary and sufficient conditions that support the formation of an RIS in Canada? Are these conditions, economic or social (including culture), or both? Is there a "critical economic mass" for the creation of an RIS, and is there a "critical density", to borrow terms from the realm of nuclear energy? For example, does the Maritime region of Canada have sufficient "density" of innovation, to form a coherent RIS? Are BC and Alberta separate RIS, and does the Manitoba/Saskatchewan region form a single RIS?

The performance of systems of innovation could be addressed taking into account at least three different "elements": i) policy instruments set up to promote innovation and S&T; ii) institutions (formal structures) related to innovation and technological development, and, iii) rules, norms and laws that pattern the behaviour within an innovation system. These apply equally to a NIS as to a RIS, where the institutions, the policy instruments and the culture should be different from another region. This would argue that RIS cannot cross provincial boundaries unless there over-riding reasons for doing so. Can Canadian RIS extend beyond provincial boundaries, or, such as the Ottawa and the greater Toronto RIS, be contained within one province?

Initial evidence suggests that innovation policy must not only focus on public investment in science and technology but also on issues such as venture capital financing, human capital development and the factors that influence the quality of life in a city[9]. In Canada single cities appear to be at the centres of RIS[10]. If one takes two hours by surface transportation as an arbitrary travel time to travel from the centre to the periphery of an RIS, there are six such centres with populations of more than one million in Canada:

[8] The only two Canadian regions studied by Cooke were Ontario and Québec. The rest of the provinces mentioned are an initial estimate of how they might be classified according to the framework given by Cooke. Detailed analysis might well argue for different assignments.

[9] The reader should review several of the papers by Richard Florida on this subject; his results, which were based on research in the USA, have been replicated for Canada by (Gertler, Florida, Gates, & Vinodrai, 2002) and can be found at www.competeprosper.ca.

[10] See, for example, the argument by Niosi & Bas (2001) regarding biotechnology firms

Table 4. Major urban agglomerations in Canada

Major cities***	Population (million)*	Other smaller cities* within 2 hours	Total population	Notes
Toronto (Ontario)	4.7	Hamilton, London, Kitchener-Waterloo, St.Catherines, Oshawa, Barrie, Guelph	7.1	
Montreal (Québec)	3.4	Québec City, Trois-Rivieres, Sherbrooke	4.4	
Vancouver (BC)	2.0	Abbotsford	2.2	Victoria is over 2 hours from Vancouver because it is on an island
Ottawa-Hull (Ontario**)	1.0			Ottawa-Hull is over 2 hours from Montreal
Calgary (Alberta)	1.0			Calgary and Edmonton are about 3 hours apart
Edmonton (Alberta)	1.0			

Source: Statistics Canada 2001 Census.
* Cities are census areas as defined by Statistics Canada.
** Hull is in Quebec, but economically part of Ottawa.
*** The next largest centre is Winnipeg, with a population of about 700,000.

The ISRN project is looking at industrial clusters in these centres, but it is not taking the existence of a cluster as given. Just as there are necessary and sufficient conditions for RIS, so too there are necessary and sufficient conditions for the existence clusters. One of the tests proposed is whether or not a cluster can survive the closure or removal of one of its main actors (whether a private firm or a public sector lab). ISRN is also looking at clusters outside the centres listed above (in the Maritimes and the Prairies): one of the major issues in each of these clusters is whether it fail the test of loss of a major actor.

5. Conclusions

This study is a work in progress, which will be informed and extended by the work of the ISRN research teams as they study the characteristics of clusters across Canada. The commonalities and differences of the clusters may provide data on the individual RIS, but what is clear is that these similarities and differences do have to be understood. Governments, both federal and provincial, may wish to establish clusters (or perhaps even RIS), to make use of local sources of highly skilled labour, raw materials, geographical advantages, or manufacturing capabilities. But simply wanting to have a cluster, establish itself, and survive in the long run without massive ongoing injections of financial resources into such communities is not enough. There are necessary and sufficient conditions for the existence of an industrial cluster in an RIS, and these conditions probably differ from one industrial sector to another.

The traditional national innovation system approach, which fits better unitary centrally-governed countries, has been used at the federal level for institutional frameworks and policy making. Innovation policies may be more difficult to modify in a federation, where there is a higher path dependency, due to historical locational patterns of federal investments in government R&D laboratories and university research facilities, but it may be necessary in the Canadian context to develop clearly separate regional approaches for federal policies and programs.

For Canada the centres listed in the table above are likely viable RIS. There has been no evidence produced to argue that any combination of the Maritime provinces could constitute an RIS, or that either Manitoba or Saskatchewan are RIS with several viable industrial clusters each[11]. Thus the federal policy paradox: How can a single policy apply to all, and how can a federal policy ignore a majority of the provinces in the federation?

Arguably the federal government should have separate S&T and innovation policies for each RIS – federal policies should not be a case of "one size fits all". But the RIS do not neatly fit into the geography of provincial boundaries. In geographic terms, the sum of the RIS do not cover the nation – much of northern Canada is devoid of any human activity, and much of the (thinly) populated southern areas are resource-based (including agriculture).

In some policy areas (for example biotechnology) the federal government has not invested in intramural research activities to support the emergence of commercial clusters as witnessed by the growth of biotech clusters in Toronto and Vancouver even though there are no federal laboratories supporting them. Arguably federal demand-driven programs are more reflective of regional priorities, as regional concentrations of firms more accurately reflect local political and cultural conditions in the RIS. Canadian federal science, technology and innovation policy is path dependent, (as are most governments' policies!) and has not changed in the past decade , from a centrist model based on Eurpoean influences, to the more regionally based models that are now emerging in Europe and elsewhere.

Are there different approaches to regional innovation systems and clusters? Could we affirm that there are different models? There at least three: the traditional national innovation system approach, the "European" model, and a new innovation system approach still to be developed for federations. The traditional national innovation system approach fits better centrally-governed countries, and has focused on the institutional frameworks and policy making. The European model could be called a supra-national innovation system, where the European Community plays a key role on innovation and regional development, providing funds as well as policy guidelines. The third model could be named "Federal Innovation Systems", where there are complex systems of governance and policy-making, and it is at the local (metropolitan) level where policy implementation and investment budgets are effective.

[11] This is not to downgrade the importance of the Saskatoon RIS which is based on biotechnology, but it has a different structure from those RIS which have multiple industrial clusters; Phillips (2002) describes it as the "entrepot" model.

Unless the specific institutional architecture existing in federal countries is taken into account, it is not possible to fully appreciate innovation patterns and policy possibilities at national or regional level. There may in fact be a strong 'path dependence' in regional innovation patterns stemming from past federal decisions and policies which may exacerbate existing inequalities in innovative performance. Canadian science, technology and innovation policy must take into account this evolution and recognize the unique features of the Canadian federation.

Please do not delete this list, I still have to figure out how to include them automatically in my bibliography.

(Phillips, 2002)
(Langford, Wood, & Ross, 2002)
(D. Wolfe & Gertler, 1998)
(P. Cooke, Boekholt, & Todtling, 2000)
(Josty, 2002)
(Holbrook & Hughes, 1998)
(Staber & Morrison, 2000)
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