

## **Review Essay: Canada's Systems of Innovation**

Jorge Niosi  
with André Manseau and Benoît Godin  
Canada's National System of Innovation  
Montreal: McGill-Queen's University Press, 2000

Jorge Niosi  
with Tomas Gabriel Bas and Majlinda Zjegu  
Canada's Regional Innovation Systems: The Science-based Industries  
Montreal: McGill-Queen's University Press, 2005

By Eleanor D. Glor

I had the privilege of touring some of the public research facilities of the small Canadian province of Saskatchewan during the mid-1970s. I was impressed by the important public policy problems the Saskatchewan Research Council was trying to solve, such as how to expand exports by improving transportation of its resources from its land-locked location, far from ports. One lab was testing, for example, the use of pipelines to move coal. The University of Saskatchewan was likewise conducting interesting research on the basic properties of matter, by breaking apart atoms with laser beams, in an underground tunnel. Twenty-five years later I toured the National Research Council's experimental home, where they were testing a new window and furnace, but this time, for private industry. Clearly, public laboratories had changed. In attempting to understand this change, as a political scientist, I would have considered first the ideological sea-change that occurred during the mid-1980s in Canada, and the changes in government policy that accompanied it.

Professor Niosi, Professor and Canada Research Chair on the Management of Technology at the Université du Québec BMontreal, pays some attention to changes in government policy, but he structures his two books instead around changes in research and development (R&D) in Canada occurring within a *national system of innovation* (NSI). He defines the NSI as the combination of R&D done in Canada's innovating firms, universities, and public research laboratories, plus the public and private institutions that finance R&D. In book one, *Canada's National System of Innovation*, he focuses on research, while in book two, *Canada's Regional Innovation Systems: The Science-based Industries*, he emphasizes patents, measurable indications of innovation. I quibble with this definition, as it is restricted to inventions, and because it does not emphasize enough whether the inventions were implemented or commercialized, and whether societal and governmental supports for innovation are in place. He notes, for example, that there were no Canadian major breakthroughs, but does not explore this fact in detail.

Dr. Niosi participates in the pan-Canadian Innovation Systems Research Network of researchers on Canada's innovation systems, funded primarily by the Government of Canada. He has not, however, really adopted the ISRN's broader definition of innovation and a system of innovation (<http://www.utoronto.ca/isrn/aboutus.htm>):

Innovation (is) a new, or significantly improved, service, product, production technique, or management method. Recent studies of the innovation process point towards the interdependence of economic, political, social and cultural factors in determining the relative degree of success enjoyed by individual nations and regions in the global and knowledge-based economy. These studies point the way towards a better understanding of the complex interdependencies between internal firm dynamics around the innovation process and the broader institutional setting within which the firms operate.

Researchers have noted strong national, regional, or local components that influence the opportunities for science-based innovation and competitiveness of firms. The interaction of these components in geographic regions is termed the system of innovation. This includes the network of institutions in the public and private sectors whose activities and interactions initiate, import, modify and diffuse new technologies. The concept of the innovation system gives special prominence to local, regional, and national social and political institutions and mechanisms that support the innovation process. It moves the theory of industrial innovation from a simple description of the entrepreneur in an isolated firm to a consideration of how all the elements of society contribute to technological change.

Again, I have problems with this definition because it makes no room for political power. In my opinion, power regularly interferes with the evolution of the innovation process. In Canada, for example, funding for research has been defined as funding for innovation, and a good deal of it has been provided. This eliminates, by exclusion, the many other things that could be done to support innovation, such as conceptual development, including in the field of management, new methods development, funding for an Information Highway, or funding the recommendations developed through consultations with industry and research institutions through the Innovation Initiative (see review essay of Canada's Innovation Strategy in *The Innovation Journal*, Volume 8(1), 2003).

In *Canada's National System of Innovation*, Dr. Niosi reports original research up to the mid-1990s from two separate surveys—of R&D laboratories in Canada and of Canadian R&D labs abroad. *Canada's Regional Innovation Systems*, based on research from 1999-2003, focuses on the marked geographical agglomeration of innovative firms and other organizations devoted to R&D into a small number of Canadian cities. His exploration of regional systems of innovation or *clusters* addresses biotechnology, aircraft systems, telecommunications, semiconductors, and computer software.

According to Dr. Niosi, countries differ in their national systems of innovation, in terms of amounts spent, institutions that execute or fund innovation, types and intensity of flows between R&D units, and also in other ways. Countries vary as well in terms of their resource base, size, government intervention, university systems, government laboratories, national financial systems, and proportion of resources invested in R&D. Likewise, research institutions vary, in terms of mandates, internal routines and performance. Clusters are not only a Canadian phenomenon, but also an international one.

Data on patents suggest that technological capabilities are nation-specific, cumulative, and persist over time. This is a process most effectively recognized and addressed by systems analysis and is addressed by the concept of patterns in complexity analysis (more on this later).

Technical progress, Dr. Niosi claims, is the engine of economic growth. I would have liked to have seen this suggestion explored more. Developed and developing countries differ in their gross stock of capital, the duration and quality of workers' education, expenditures on R&D, and thus in terms of the ability to produce and assimilate technological and organizational innovations. Despite many differences, fifteen industrialized countries converged since 1945 in terms of productivity and per capita revenue.

Since Confederation in 1867, the public sector has played an important role both in the development of the NSI and in its rapid development in the last sixty years, as captured by Statistics Canada and other government information-gathering systems. While most research was initially done in federal government laboratories, much more has been shifted to universities and industry, following recommendations by the Glassco Commission in the mid-1960s and the Science Council in 1968. The dominance since the early 1980s of neo-liberal ideas in support of a reduced role for government and an increased role for the private sector has of course supported these shifts.

The NSI has been a major contributor to Canada's prosperity since World War II. It has gaps, inefficiencies, some overlapping of industry and government efforts, missing elements, and some lack of coordination. Canada has been challenged to assure transfer of technology from research organizations to industry. One way to address this has been through cooperative research.

Dr. Niosi also explores the internationalization of Canada's NSI through Canadian research done abroad and patents secured, and research done by foreign organizations in Canada and their patents. He calls this the internationalization of Canadian R&D, and asks whether a North American supra-national system of innovation is developing. Most of Canada's research done abroad was done in the USA, but most research done by majority-owned foreign affiliates of US parent companies was done in Germany and the UK, and only thirdly in Canada. While the USA and Canada are each others' largest trading partners, he concludes a North American system of innovation is not developing.

Despite its small domestic market, Canada had built an NSI by the 1990s, through institutional imitation of the USA and western Europe, and economic and political restructuring, while keeping its economy open to trade and investment, maintaining a stable macroeconomic foundation, and building institutions. From Confederation to 1939, the federal government focussed on complementing weak private R&D with government labs and university research. These targeted public-good knowledge for farmers, mining and other companies (as I found in Saskatchewan). Canada lagged behind other advanced countries in private and public R&D. During WW II, Canada increased its activity, mostly through defence-related labs, a vertical technology policy. Canada's support for its post-WW II priorities such as nuclear energy and aerospace emerged at this time. Following WW II, the Canadian government increased its involvement, by creating horizontal policies that nurtured private R&D, targeting specific sectors such as nuclear energy, aerospace, telecommunications, biotechnology and software, and government programming such as national laboratories and special programs. The federal government first became involved in promotion of science and technology during the 1950s. Take-off occurred in the 1960s, with development of public horizontal support such as R&D tax credits, tax deductions, and the Industrial Research Assistance Program (IRAP).

The innovative firms and other institutions focussed on R&D that developed are agglomerated. This is partly because they demand mostly skilled labour, use few natural

resources, and are not dependent on local markets as their products are easy to transport. A focus on individual organizations does not capture many aspects of innovation; however, such as the differences among large and small firms, environmental conditions such as war, whether there is a market, interactions among firms during the process of technological change, and the ways in which innovation has a systemic character. An individual focus also misses information on the science and technology base, the role of the state, and the ways in which there is a geography of innovation. This pattern has also emerged at the international level. Innovation occurs mostly in a group of twenty industrialized countries; and within those countries, primarily within a few metropolitan areas and regions.

Dr. Niosi draws on complex systems economics and evolutionary economics and management to analyze Canada's regional innovation systems (RIS). There are several advantages to an evolutionary approach. In addition to factors that a non-evolutionary approach would address, such as opportunities for knowledge, pools of talent, access to financing, transaction costs and opportunism, an evolutionary approach to RIS considers the bounded rationality of agents, change, adaptation to macroeconomic and macro-political change in the environment, chance, initial conditions, and attractors.

Organizational attractors in the Canadian NSI, for example, have varied by industry. In aircraft, the attractor was a large assembler; in biotechnology, a large research university; in information technologies, a large research-intensive corporation. These anchors in turn created regional demand for specialized producers and concentrated labour pools from which small and medium enterprises could emerge.

While these factors are sufficient to explain development of clusters, I found it interesting that priority areas identified by government during World War II have become and remain Canada's RISs or clusters today. They emerged, as government desired, they took on a life of their own, and they remain the predominant areas of innovation in Canada today. As in the USA, but in a different way, government has played an important role in the development of both a national system of innovation and regional systems of innovation in Canada.

Eleanor Glor is a public servant who has worked for four governments at the municipal, provincial and federal level, and also for the non-profit and private sectors.