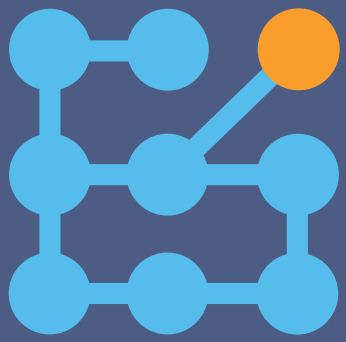
CANADA'S INNOVATION PUZZLE: IS OUR NATIONAL CONVERSATION MISSING A PIECE?



John Stewart

Canadians have been concerned for decades about their country's level of research and development activity, which is presumably related to productivity and living standards. However, recent major national studies and policy efforts related to R&D have focused almost exclusively on business performance of R&D. As policy-makers in the US and other major innovator countries recognize, public institutions such as national laboratories are an integral part of national science and technology performance, as they concentrate many diverse researchers together, offer training opportunities for highly qualified personnel in many fields, and can supply R&D facilities and services that may not be offered by private institutions, regardless of incentives. Policy efforts must look at the full ecosystem of public, academic and private institutions to have a complete picture of national science and technology performance.

Les Canadiens s'interrogent depuis des décennies sur l'intensité des activités de recherche et développement, qui sont censées stimuler la productivité du pays et améliorer leur niveau de vie. Or les grandes études nationales sur la question et les efforts politiques de la période récente ont presque exclusivement ciblé la R-D effectuée par les entreprises. Comme le reconnaissent désormais les décideurs américains et d'autres grands pays innovants, les institutions publiques comme les laboratoires nationaux sont pourtant partie intégrante du rendement des sciences et des technologies, puisqu'elles regroupent des chercheurs aux horizons variés, assurent dans plusieurs domaines la formation d'un personnel hautement qualifié, et offrent des installations et des services de R-D que les institutions privées ne peuvent fournir, quelles que soient les incitations dont elles bénéficient. C'est donc tout l'« écosystème » des institutions publiques, universitaires et privées qu'il faut examiner pour dresser un portrait fidèle du rendement des sciences et des technologies du pays.

Some public policy dialogues are short, lively and full of fireworks. Others are slow and quiet. Canadians' national conversation on innovation and productivity has been going on for decades. Its modern chapter dates to the late Trudeau years — to the birth of Donald S. Macdonald's 1982-85 Royal Commission on the Economic Union and Development Prospects for Canada.

The Macdonald Commission provided much of the foundation for market-oriented policies pursued by federal governments under Prime Ministers Brian Mulroney (1984-1993) and Jean Chrétien (1993-2004). The goal of the commission and many of those policies was to ensure the maintenance and growth of Canadian living standards. That led Canadians into a decades-long discussion of innovation and productivity.

While most of us are aware that innovation is important for prosperity, it is worthwhile to review the chain of causes and effects. Specifically, productivity gains are the main drivers of sustained advances in living standards. Those productivity gains mainly occur in manufacturing, and manufacturing productivity depends on innovation in both processes and products.

So if we want to advance Canada's living standards, we need innovation in industry, and particularly in manufacturing.

Canada's innovation landscape varies markedly from the average among OECD countries, making the picture more complicated. Canadian R&D scores relatively highly on measures of international openness (such as rates of foreign financing and patents with foreign co-inventors). And we have good education and training in science and engineering.

On the other hand, decade after decade we have seen quite low rates of spending on R&D compared with those of other fully industrialized countries, whether we are measuring research and development on business (business expenditure on research and development, or BERD) or across all sectors (gross expenditure on R&D, or GERD). According to the OECD, Canada also shows relatively low venture capital activity and low patent rates.

While it is not clear to what extent BERD or GERD correlates to actual innovation, this lack of R&D spending in Canada is thought to explain why our per capita income is about 20 percent less than that of our neighbours in the United States.

Partly because that gap in per capita income vis-à-vis the United States shows little sign of narrowing, and partly because we are anxious to remain competitive, we continue to worry about our R&D performance and how to improve it. The approach taken in recent decades has been to encourage BERD through various government measures, notably through the tax system.

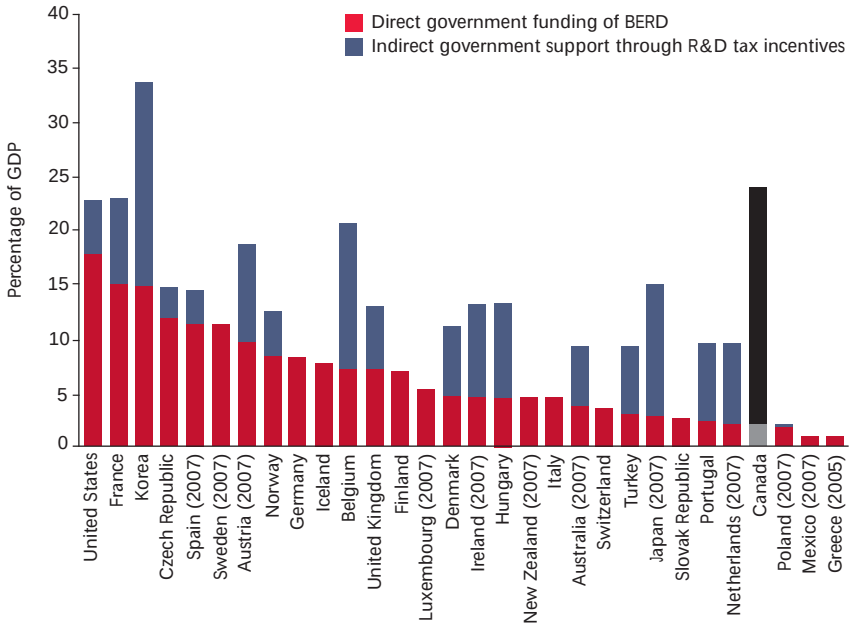
In 2008, Canada's direct and indirect funding to business R&D was higher than in the US, and was the second highest among 30 OECD countries (figure 1). Much of this funding was accomplished through tax incentives such as the Scientific Research and Experimental Development Tax Incentive Program. If numbers of personnel that are claimed to be engaged in R&D are any indication, the incentives must be effective: according to Statistics Canada data those numbers climbed 66 percent in the business sector from 1999 to 2006, while university research had staff growth of around 28 percent, and in both federal and provincial government they were more or less flat. (Of course, it is possible that the availability of incentives for business R&D leads firms to inflate their accounting of how much research they are performing and how many employees are performing it.)

It is fair to say that the Canadian government's strategy on science and technology, R&D and innovation in recent years has been focusing increasingly on the business side of the innovation system.

When we compare Canada's approach to the innovation-productivity debate (box 1) with the national conversation that has been taking place in the US during the same period (box 2), we find that the US policy conversation consistently talks about the contributions of both business and government to a combined innovation ecosystem, while Canada's policy conversation is largely confined to examining only the business side of that system.

Skeptical Canadians reading this might raise some objections. First, hasn't the Americans' experience with financial crisis and recession given their outlook a temporary interventionist bias? Answer: The conversation cited in box 2 began in

FIGURE 1. PROPORTION OF GDP SPENT ON BUSINESS RESEARCH AND DEVELOPMENT, AND TAX INCENTIVES FOR R&D, OECD COUNTRIES, 2008



Source: OECD, *Science, Technology and Industry Outlook*, 2010, fig. 2.1, http://www.oecd.org/document/36/0,3746,en_2649_34273_41546660_1_1_1_1,00.html.

Box 1. Highlights of recent major analytical and policy initiatives in Canada related to innovation

- **Canada's 2007 Science and Technology Strategy, "Mobilizing Science and Technology to Canada's Advantage**," talks primarily about "enabling private investment." The government's role is seen as optimizing the impact of its incentives on businesses.
- **Canada's 2009 Expert Panel on Business Innovation** explicitly limits its scope to the determinants of business innovation. It finds that Canadian businesses tend to be "technology followers, not leaders." The panel's report calls for deeper analysis of areas where Canadian business seems to underperform, such as low investment in information and communications technologies, and the investment climate for new ventures.
- **Canada's current Review of Federal Support to Research and Development** explicitly will not review research in federal labs or universities, other than that which is intended to foster support to business R&D.

2005 — and the US government's system of National Laboratories has been central to US science policy for the past 70 years. Second, doesn't the large US defence establishment help to support their national research infrastructure? Answer: Other highly innovative, high-productivity, fully industrialized countries, such as Germany and Japan, also do proportionately more research in government institutes than does Canada (figure 2), though they have small defence establishments and low rates of military spending. And third, of course Americans don't worry about encouraging business, since they already have one of the most innovative business sectors in the world. Answer: Perhaps the US is encouraging business innovation by investing in public R&D infrastructure in greater proportion than we do (see box 2).

While most of us are aware that innovation is important for prosperity, it is worthwhile to review the chain of causes and effects. Specifically, productivity advances are the main driver of sustained advances in living standards. Those productivity advances mainly occur in manufacturing, and manufacturing productivity depends on innovation in both processes and products.

Our American neighbour knows that a complete national conversation on innovation — let alone a complete national policy on innovation — can't exclude the role of public infrastructure and actual government activity. And this is also the case in other leading innovator countries, namely Korea, Germany, China and Japan.

Markets do sometimes fail to deliver an economic good or service, no matter how good an investment that good or service may be for society as a whole. A classic example of such a "public good" is a lighthouse on a rocky coast. The lighthouse easily saves vastly more in lives, cargo and ships than it costs to operate. However, since there is no efficient way to collect revenue from those beneficiaries, no profit-seeking private investor will build the lighthouse.

Therefore, only government can fund a lighthouse. It may use a competitive bidding process, it may award construction to a profit-making firm, and that firm may have private investors, but none of this changes the fact that only government can fund the lighthouse. Tax incentives will not do the job in this case, because the revenues for providing this service are not only low, but uncollectible.

Some national infrastructure is more amenable to public-private partnerships than a lighthouse is. Toll highways and bridges can efficiently collect revenue from their beneficiaries. Defence and security services are somewhere in the middle: while they are often able to make profits from a limited number of paying clients, most of us agree that it is better if we treat them as public goods and expect them to bring a degree of security to everyone.

Governments fund and operate research laboratories in all economically advanced countries. In Canada, four of the largest operators of such labs are the National Research Council, Agriculture and Agri-Food Canada, National Defence and Atomic Energy of Canada Ltd. When one sets out to analyze national R&D performance, it is too easy to assume that these labs merely compete against business to produce an undifferentiated output called R&D — and, by implication, that we could reduce the need for these labs if business produced more of that output.

In fact, there is solid OECD evidence that public and private R&D are complementary. First, public laboratory infrastructure permits investigations whose payoff may be very large, but is too uncertain or unknowable for private firms to finance. Second, there are

Box 2. Highlights of recent major analytical and policy initiatives in the United States related to innovation.

- **The US's 2007 National Academies "Gathering Storm" Report on US science and technology**. In its recommendations, encouraging business innovation ranks below the following priorities: increasing federal basic research funding in the physical sciences, mathematics and engineering; modernizing aging national research facilities; and establishing an Advanced Research Projects Authority for Energy (ARPA-E). These priorities received broad congressional support. Establishment of ARPA-E was authorized in 2007 and other "Gathering Storm" recommendations were funded in 2009.
- **The US's 2010 "Four Policy Principles" Report by the Consortium for Science, Policy and Outcomes** advises that, while most innovation occurs in the private sector, there are many good examples of government-sponsored innovation (notably encouraged through government procurement). This report also stresses that a "public works model" is particularly relevant to energy innovation. This report's key proposals have won administration support.
- **The US President's 2011 State of the Union Address**, after recognizing that "free enterprise is what drives innovation," stresses the contribution made by government to the innovation system that produced integrated circuits, GPS and the Internet. President Barack Obama emphasizes the potential for policy to generate a "Sputnik moment" that will raise the US's level of R&D in biomedical research, information technology and clean energy.

what economists Michael Bordt, Daood Hamdani and Pierre Therrien called in 2006 "spillover" effects from public R&D that "increase the chances of a successful outcome" in the private sector. Third, even in the shorter-run commercial sphere, public labs can be a necessary enabler or precondition for some business R&D.

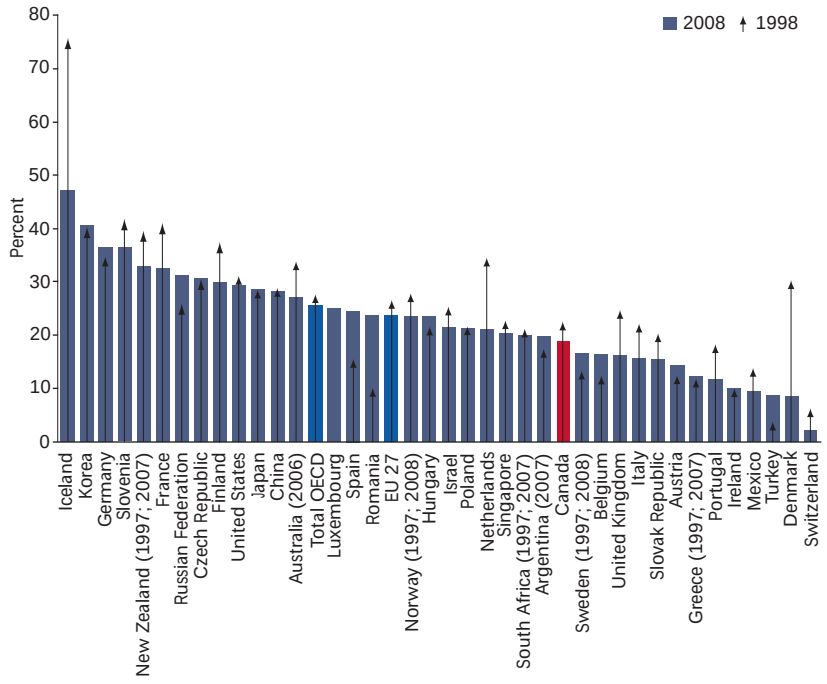
This is clearly evident in the area of advanced materials research, which is crucial to modern manufacturing, since advanced manufactured products depend on selection and formulation of the right materials (such as alloys, plastics, ceramics, glass or carbon fibre composites and wood composites). Public R&D infrastructure provides laboratory services that, at least currently, are simply unobtainable (or, at best, are in very short supply) from commercial sources and, indeed, may never be provided by private organizations anywhere, no matter what incentives are available. Business will pay fairly for access to these R&D facilities, but only governments build them.

Neutron beam testing facilities are just one case of this market failure. Business obviously finds such facilities to be necessary for the testing of parts and materials, but there is no real indication anywhere in the world that private investors will build them.

Public R&D facilities directly enable business research and development. They do this in ways that no tax incentive will, since no tax incentive will lead to a viable business case for building such facilities.

They also encourage business R&D in many indirect ways, many of them related to highly qualified personnel (HQP) in sciences and engineering. These facilities provide key development experiences for HQP who may spend a week, or a season, working in them at some point in their careers. Also, a country's scientists and engineers — no matter where employed — benefit from the existence of good government laboratories at home when they do international work. Coming from a country with a solid public research establishment enhances their status at foreign institutions, helping them to share the resources and knowledge of international counterparts.

FIGURE 2. PROPORTION OF GDP SPENT ON RESEARCH IN GOVERNMENT INSTITUTES, OECD COUNTRIES



Source: OECD, *Science, Technology and Industry Outlook*, 2010 (fig. 1.6).

The bottom line is that there are reasons why advanced, innovative economies build national research facilities — and why, on average, they do it on a larger scale than we do here in Canada. In the OECD's survey of 38 industrial or industrializing countries (figure 2), Canada ranks 25th, far behind leading innovator countries (Korea is 2nd, Germany 3rd, the US 10th, Japan 11th and China 12th).

When Canada's performance and recent policy thinking are placed in international context, a picture emerges of a country that is somewhat preoccupied with tax-incenting business R&D and gives comparatively little thought to its public sector research infrastructure. The current approach, if it is sustained, will simply bypass consideration of the contribution made by that infrastructure.

There should be due consideration given to the possibility that public laboratories play a central role in national innovation performance. The way to do this is to broaden our national dialogue about innovation by looking beyond the business sector, and asking such questions as: What assets do we have in our publicly funded research establishments? What have they contributed to Canadian innovation? What are their current linkages to industry research? Are these assets being funded and governed in optimal ways?

These questions are integral to innovation policy. The answers will tell us a great deal about the context in which business makes its R&D and innovation decisions. Asking them is essential to deciphering Canada's national innovation puzzle.

John Stewart is Director of Policy and Research with the Canadian Nuclear Association. The CNA represents tens of thousands of Canadians in a broad range of organizations that work to bring the benefits of nuclear technology to Canada's households and businesses through mining, fuel fabrication, electricity generation, medicine, food safety, research and development and many other activities.