Chapter 6

Promoting Productivity Growth by Encouraging Innovation

By Steven Globerman

Introduction

It is well established empirically that technological change is the main driver of total factor productivity[17] growth over time (Crafts, 2008). Technological change, in turn, can be characterized as a process by which new scientific and engineering concepts are developed, initially embodied in new products, production processes, and organizational forms and procedures, and subsequently widely adopted and used by private and public sector organizations.

The various stages of the technological change process have sometimes been compartmentalized into the invention, innovation, and diffusion stages. Invention corresponds to the formal or informal creation of new knowledge. Innovation encompasses the development of "practical" ways to use new knowledge, including producing and testing "beta" versions, as well the initial introduction and use of refined versions of the beta model. Diffusion refers to the widespread use of the innovation, either by existing firms or by new start-ups.

While the technological change process is sometimes presented as linear, in fact, there is typically feedback from diffusion to invention, i.e., the use of a new product or process leads to insights that, in turn, lead to improvements in the innovation being adopted.[18] Indeed, the improve-

[17] Total factor productivity, in simple terms, is the ratio of the value of output produced to the value of all inputs used to produce the output.

[18] For a discussion of the interaction between invention, innovation, and adoption, as well as some evidence on the importance of even modest (or incremental) changes to

ments can be thought of as "follow-on" innovations that, in turn, promote increased adoption of the innovations in question. Entrepreneurship and intrapreneurship[19] also promote the use of innovative processes and products by making the innovations widely available (directly or indirectly) through marketing them directly to potential users or by using them in-house to improve efficiency.

Numerous studies and reports by scientific commissions have identified Canada's innovation gap.[20] To be sure, a slowdown in innovation has been identified as a widespread source of the multi-decade slowdown in productivity growth that characterizes all developed economies. Gordon (2017) is perhaps the most well-known proponent of the view that society has already exploited the potential ideas that lead to major innovations. Bloom, Jones, Van Reenan, and Webb (2020) offer a more nuanced position. They argue that the costs of discovering and developing new ideas that underlie innovation have increased substantially since at least 1930. However, others such as Brynjolfsson and McAfee (2014) and Mokyr (2013) dispute the notion that society faces a more limited potential for innovation.

While basic scientific breakthroughs clearly expand the opportunity set for major innovations, there will continue to be opportunities for secondary innovations that are an important source for ongoing productivity improvements. Furthermore, relatively small countries such as Canada are unlikely to be major contributors to advances in basic science along a wide range of disciplines. Rather, the main opportunities for small, open economies lie in leveraging scientific advances into commercial innovations and using and marketing those innovations.

This chapter briefly assesses Canada's recent performance in innovation relative to other developed economies and discusses policies that might improve Canada's performance. There exists a wide range of factors that influence innovation performance at the national level, and it is beyond the scope of this relatively focused essay to address all of the relevant factors. Hence, the essay focuses on factors that seem to be particularly important contributors to Canada's relatively poor innovation perform-

existing best practices for productivity growth, see Globerman and Lybecker (2014).

19 Entrepreneurship is typically equated with start-up organizations that develop and commercialize innovations to produce new products and/or to produce existing products more efficiently. Intrapreneurship is usually equated with departments within existing organizations that develop innovations either for internal use by those organizations or for more widespread commercialization. For a discussion of entrepreneurship and intrapreneurship and their role in promoting productivity growth, see the essay by Sobel in this volume.

20 For a review and update of this evidence, see Globerman and Emes (2019).

ance over decades, notwithstanding numerous federal government programs aimed at stimulating innovation activity.

Overview of Canada's innovation performance

A general definition of innovation encompasses the implementation of a new or significantly improved product or process, a new marketing method, or a new organizational method. As Globerman and Emes (2019) note, while studies have used numerous available measures of innovation, no single measure is definitive or without flaws. This is an argument for using so-called league tables, which combine an array of measures that are directly or indirectly representative of national innovation performance.

There are two primary and publicly available league tables that rank the innovation performance of countries. One is the World Economic Forum's *Global Competitiveness Index*. The second is the *Global Innovation Index* produced by a consortium of universities.[21] This essay's tables 1 and 2 report data from these two sources that identify Canada's innovation performance relative to other countries. Specifically, they report Canada's ranking relative to other countries based on the criteria used by the two league tables. They also report Canada's overall numerical score relative to the score of the "leading" country, as well as Canada's score relative to the United States.[22]

Although the two league tables use somewhat different criteria and different methodologies to measure innovation performance, both show Canada being well down the league rankings. While the *Global Competitiveness Index* shows a slight improvement in Canada's standing in 2019 compared to earlier years, the *Global Innovation Index* reports, if anything, a declining performance in 2019 compared to earlier years. The main point to take away from tables 1 and 2 is that Canada has performed relatively poorly on innovation compared to other countries over a sustained period.

A ranking of the top technology clusters among major metropolitan areas provides yet another indicator of Canada's relatively poor innovation performance. It is well established that innovation activity tends to be geographically concentrated in specific metropolitan areas (Filipowicz, Globerman, and Emes, 2019). The *Global Innovation Index* (2019) provides a ranking of the top 100 metropolitan areas in the world based on the criterion of being an "innovation cluster." Among all Canadian metro-

[21] Globerman and Emes (2019) discuss the methodologies used to produce these two surveys.

[22] The leading country in both surveys can vary from year to year.

Table 1: Canada's Relative Performance on the Innovation Pillar of the Global Competitiveness Index

	Canada's rank	Canada's score relative to leader	Canada's score relative to US
2007-2018 Average	18	0.817	0.837
2019	16	0.853	0.88

Source: For 2007-2018: Globerman and Emes (2019)

For 2019: World Economic Forum, Global Competitiveness Report, 2019.

Table 2: Canada's Relative Performance on Overall Innovation Capability

	Canada's rank	Canada's score relative to leader	Canada's score relative to US
2011-2018 Average	14	0.832	0.931
2019	17	0.866	0.873

Source: For 2007-2018: Globerman and Emes (2019)

For 2019: Dutter, Lanvin and Wunsch-Vincent, eds., Global Innovation Index, 2019

politan areas only Toronto with a ranking of 39 makes it into the top 50 areas listed. At a rank of 51, Montreal is just outside the top 50. The only other Canadian metropolitan area to break into the top 100 is Vancouver—ranked number 72.

Improving Canada's innovation performance

As noted earlier, the Canadian government has, over time, established numerous programs to fund innovation-related activities. The available data and information suggest that the government's efforts have been largely unsuccessful. The obvious question one might ask is what Canada, or for that matter any other country, should do to improve its innovation performance.

The literature offers many suggestions. The specific recommendations for promoting innovation performance broadly encompass improving the institutions that encourage innovation and increasing the supply of

Figure 1: Factors Conditioning Innovation

- Legal and political institutions
- Human capital and skills
- Domestic and foreign competition
- Financing/entrepreneurship
- ICT infrastructure
- R&D resources/performance

critical inputs to the innovation process. Figure 1 attempts to summarize the main factors that have been identified, drawing upon the criteria used in the *Global Competitiveness Index* and the *Global Innovation Index.*

Legal and political institutions

A favourable (to innovation) legal and political institutional environment encompasses a relatively strong property rights regime, especially in the context of intellectual property, and more generally, the transparent and consistent rule of law. Burdensome regulation, particularly with regard to starting and operating new businesses, as well as relatively high tax rates, discourage innovation.

Human capital and skills

While a more highly educated workforce is generally supportive of innovation and productivity growth, a higher percentage of university graduates in science and engineering disciplines is especially supportive, as is more widespread digital skills in the population.

Competition

Competition in both output and input markets encourages the introduction and adoption of new technology. Product market competition encompasses both rivalry between domestic firms and the actual or potential threat of imports and inward foreign direct investment. Internal labour

mobility and ease of hiring foreign workers are important contributors to competition in the labour market.

Financing/entrepreneurship

Since innovation is often introduced by start-up ventures, a stronger entrepreneurial culture contributes to an innovative environment. The availability of venture capital and later-stage financing for small (often start-up) and medium-sized enterprises is frequently cited as a necessary, if not sufficient, condition for promoting innovation through the activities of start-ups and incumbent small enterprises.

Information and communications technology infrastructure

A robust information and communications technology (ICT) infrastructure is increasingly critical to support the creation and use of new technology, especially given the increasingly complex and dispersed cooperative research that universities and affiliates of multinational companies carry out. An efficient ICT infrastructure also promotes competition by facilitating price discovery and an expansion of geographic markets for products and services.

Research and development financing and performance

Research and development (R&D) is obviously a critical activity underlying innovation. However, simply spending more money on R&D does not necessarily ensure an equivalent increase in innovation. In particular, if the R&D funder is a different organization than the R&D performer, a potential principal-agent problem is created. Specifically, the objectives of the funder and the performer might be misaligned. Furthermore, the funder is likely to find it difficult to monitor the activities of the performer to ensure that the latter is being efficient and effective in carrying out the R&D activity. This is likely to be challenging in the context of R&D where measurable outputs and timelines are difficult to specify in advance of funding.

Applying the criteria to Canada

The *Global Innovation Index* and the *World Competitiveness Report* provide detailed evaluations of the relative strengths and weaknesses of Canada's innovation environment relative to the broad criteria listed in figure 1. While there is some disagreement between the two surveys with respect to specific criteria, the overall assessments are fairly congruent. One notable source of agreement is with respect to limited competition in domestic markets, where Canada's ranking is well below its overall innovation ranking. Part of the explanation for limited competition is substantial non-tariff barriers in services, particularly ICT services, which includes barriers to inflows of foreign direct investment. Barriers to competition directly reduce incentives to innovate, while barriers to foreign competition in telecommunications weaken the contribution of advanced infrastructure to improved innovation.

Another prominent weakness is Canada's relatively weak rates of physical and human capital formation. With respect to the latter, the relatively limited growth of scientists and engineers is seen as a particularly relevant restraint on innovation. Relatively high business and personal income tax rates are seen as slowing the growth of capital formation, while restrictions on internal labour market mobility and difficulties in hiring skilled STEM workers from abroad exacerbate the scarcities of human capital.

A third prominent weakness is the relatively limited funding and performance of R&D in Canada's private sector. By way of illustration, in 2017, business enterprises in Canada carried out approximately 52 percent of the country's total R&D spending. In the other G7 countries, business enterprises performed, on average, about 69 percent of total R&D.[23] In contrast, about 41 percent of R&D in Canada in that year was carried out by universities compared to 18.5 percent in other G7 countries. This distribution might help explain why Canada scores quite highly on the criterion of producing scientific publications, while at the same time lagging on commercialization of R&D.

There is less agreement between the two sources on other criteria listed in figure 1. For example, while both sources agree that Canada's overall financial system is strong and that large business can access capital on reasonable terms, there is some disagreement on the ease with which start-up and incumbent small and medium-sized business can access financial capital. Also, while the *Global Competitiveness Index* highlights

[23] See Statistics Canada, Table 27-10-0360-01. The other G7 countries are France, Germany, Italy, Japan, the UK, and the US.

a need for stronger IP protection in Canada, the *Global Innovation Index* does not.

Concluding comments

Innovation is a complex phenomenon that is not amenable to easy prescriptions for success. Nevertheless, several broad conclusions can be drawn. Namely, nations are likely to have more innovative economies when their governments forebear from suppressing market competition and provide a legal, regulatory, and tax environment that encourages investment in physical and human capital, both by domestic and foreign investors. In addition, while there is an important role for government to play in funding basic research, the funding and performance of applied research and development is better left primarily to private sector decisionmakers.

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