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Innovation and Productivity

Innovation and the Productivity Problem

Any Solutions?

Donald G. McFetridge

IRPP

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Innovation and Productivity /Innovation et productivité

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The most important high-level driver of productivity is innovation, which is itself the result of complex and poorly understood interactions between research and development, education, investment and a host of other factors. The goal of this project is to examine the channels by which efforts to improve Canada's innovation performance can result in productivity improvements.

Le levier essentiel de la productivité est l'innovation, elle-même le résultat d'interactions complexes et souvent mal comprises entre la recherche-développement, l'éducation, l'investissement et une multitude d'autres facteurs. Ce projet vise à examiner différentes mesures permettant de favoriser l'effort d''innovation au Canada et, par conséquent, d'améliorer la productivité.

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Introduction

Canada's productivity growth record has been mediocre by international standards, which does not bode well for our future standard of living. Many explanations have been advanced and, indeed, many factors have been in play over the years. A recurring theme is that Canada's disappointing record is due in part to a lack of innovation in the business sector of the economy. For more than 40 years, this theme has been the subject of debate and a virtually endless series of remedial policies, and the focus of numerous federal and provincial government programs. Ministries, departments, councils, committees and panels have come and gone. Yet neither Canada's record on productivity growth nor that on commercial innovation appears to have improved appreciably relative to the experience of other advanced countries. Indeed, they may have become worse.

The apparent lack of incentive for commercial innovation has been intractable from a policy perspective. Although the problem might have been worse were it not for the programs that have been put in place, it is hard to avoid the conclusion that results have fallen well short of expectations. This paper addresses the question of whether federal policy responses have been misdirected or misapplied. Have policy-makers learned anything? If it was misguided before, is policy on the right track now?

The paper takes a historical perspective, since the disenchantment with public policy toward commercial innovation goes back a long way. In a 1970 report, the Senate Special Committee on Science Policy concluded that

> [s]ince 1916, too, the main objective of Canadian science policy has been to promote technological innovation by industry.... Almost every decade since the 1920s has wit-

> nessed renewed attempts by successive governments to achieve it but, on the whole, they have all failed. What progress has been made in this respect results almost exclusively from the initiative of industry itself. (1970, 111)

If innovation policy has not accomplished much, it is not for want of attention, at least during the past half-century — Canada ranks highly internationally in the study of innovation policy, if not in innovation itself. Contrary to George Bernard Shaw, we can learn something from history, at least in this case. There are some commonalities. Some support programs, either by design or default, have pursued a variety of objectives of which some were antithetical to innovation. Policy might also have had too narrow a focus, placing too much emphasis on reducing the perceived cost of business research and development (R&D) and not enough on making the economic climate more hospitable to entrepreneurship.

The debate over public policy toward commercial innovation runs along deep and familiar lines. There is the big government-small government debate, with proponents of the former advocating high taxes and selective give-backs to encourage specific manifestations of innovative behaviour, while advocates of the latter recommend lower taxes in general. There is the nationalist-internationalist debate, with nationalists focusing on the development of and reliance on domestic institutions and linkages, while internationalists recognize the role that immigration, foreign institutions and linkages and foreign-owned firms play in the innovative process. There is the structuralist-behaviourist debate, with structuralists advocating support of designated ("strategic") industries and firms ("winners," "champions" or "anchor tenants"), while behaviourists focus on the impediments to innovation that existing firms and industries face.

The innovation issue runs deeper yet. There is much talk about the need for an innovation culture. At one level this is trivial — amounting to periodic exhortations from politicians, think tanks and business leaders to be more innovative. There is, however, something more fundamental involved. Any important innovation threatens existing interests and entitlements, and threatened interest groups might be able to forestall innovation politically. It is the degree to which the political process insulates itself from the pressures of entrenched interests that is the mark of an innovative society. A political environment in which innovation policy is merely a payoff to one more lobby group ("the science lobby") is unlikely to generate much in the way of either innovation or productivity growth.

A road map

I begin with a discussion of the productivity growth and commercial innovation problems. This is important, because productivity growth rates can vary for many reasons and innovation is difficult to measure. Innovation takes a variety of forms and there is no particular reason for Canada to mirror another country. If it ain't broke, we don't need to fix it. Those seeking to have their agenda implemented argue there is a crisis that demands attention. Is there a crisis?

I then discuss characteristics of the Canadian economy that impede innovation. Here I note the importance of distinguishing among factors that are readily amenable to changes in public policy, those that might be amenable over the long term to fundamental policy shifts and those that are immutable.

I then go on to examine policies and policy options with regard to various features of the innovation system. These include linkages and linking institutions, financing, tax incentives and direct government support of business innovation. I offer some concluding observations in the final section.

Some basic concepts

Discussions of public policy toward innovation often refer to "innovation systems" and "externalities" or "spillovers," terms I also use in various places in this paper, so it is important to define them.

An innovation system is the totality of knowledge-producing and knowledge-using organizations and the interactions among them. The national systems approach recognizes that innovation can be the result of learning-by-using and learning-by-doing, as well as various forms of research activities of varying degrees of formality and orientation. This approach emphasizes the importance of linkages among the various sources of learning and also of linking and facilitating institutions. One insight of the innovation systems approach is that sustained innovation is often a consequence of the existence of a geographically concentrated critical mass (cluster) of innovating organizations.

A positive externality is a benefit conferred on others for which the source of the benefit is not compensated. This is often referred to as a positive spillover, although the term is frequently misused. Innovation generates positive externalities to the extent that the innovator is unable to appropriate the fruits of it. The benefits of an innovation are inappropriable, at least in part, if it can be copied, reverse engineered or otherwise pirated by others. Innovations of this nature might be unprofitable even if they are beneficial to the economy as a whole, in which case, public policy can encourage innovative activities that are unprofitable but likely to yield high economy-wide (social) rates of return.[1]

Public policy can encourage socially beneficial but unprofitable innovative activities in many ways. Intellectual property rights (patents, copyrights, trademarks) serve this purpose, as do "neighbouring rights" (such as fees paid by users of copyrighted material, taxes on blank audio tapes and CDs rebated to composers and performers). Subsidies and tax incentives can also be used as a top-up when profitability is insufficient but the economy-wide rate of return is high. This is called the "economic efficiency rationale" for the support of innovation. Experience shows, however, that this concept is not easy to operationalize.

The Productivity Growth Problem

The first question to deal with is whether there is a productivity growth problem. Sharpe makes a convincing case that the rate of growth in labour productivity in Canada has been low by international standards and especially in comparison with the United States:

> Canada's productivity growth record has been dismal, both from an historical and an international perspective. Since 2000, Canada's labour productivity performance has deteriorated relative to both our performance during the second half of the 1990s and relative to the performance of labour productivity in the United States in the 2000s.... Canada's manufacturing productivity performance since 2000 has been even worse than the business sector performance. Output per hour advanced at only a 0.6 per cent average annual rate between 2000 and 2006, compared to 5.5 per cent per year in the United States. In other words, U.S. manufacturing labour productivity growth has been nearly ten times as fast as that of Canada! (2007, 21)

A number of other commentators have come to the same conclusion. Hodgson, for example, says, "Canada is a laggard on productivity, which directly affects its standard of living. Indeed, Canada has lagged behind most major OECD [Organisation for Economic Co-operation and Development] countries in productivity growth for decades. From 2000 to 2005, Canada's annual productivity growth ranked 10th among 17 higher income OECD countries" (2007, 3). Statistics Canada reports that Canadian labour productivity was 92.6 percent of US labour productivity in 1994, rose to 94.1 percent of the US level in 2000, then collapsed to 89 percent in 2005, and cites several factors that may have contributed to this decline: "In recent years, the Canadian economy has experienced several shocks, including the severe acute respiratory syndrome crisis, the outbreak of [mad cow disease], the power blackout in Ontario, and the sharp appreciation of the Canadian dollar" (2007a, 3).

Dion provides more detail (see table 1), also observing that Canadian labour productivity growth accelerated during the late 1990s only to fall back below its ("sluggish") historic growth rate after 2000 (2007, 20). He notes that one can see a similar though less pronounced pattern in productivity growth rates in the European Union, Australia and New Zealand. The United States, in contrast, experienced an increase in its rate of labour productivity growth after 2000. It is apparent that, while Canada has had favourable productivity growth at times and relative to certain other countries, the general conclusion that Canada has been a laggard is not unwarranted.

Table 1
Average Annual Growth in GDP Per Hour Worked (Total Economy), Selected Economies, 1974-2005 (percent)

	1974-96	1997-2005	1997-2000	2001-05
Canada	1.2	1.9	2.9	1.1
United States	1.3	2.4	2.1	2.5
European Union	2.7	1.5	1.9	1.2
United Kingdom	2.2	2.1	2.5	1.9
Australia	1.7	1.9	2.1	1.7
New Zealand	0.8	1.3	1.6	1.0

Source: Dion (2007, table 1).

Growth accounting

Potential solutions to the problem of slow growth in labour productivity vary depending on the reason that growth has been slow. The sources of labour productivity growth are:

- improvements in labour quality due to education, training and experience;
- increases in the amount of capital (tools, equipment, machines and structures) that workers have at their disposal (capital deepening); and
- improvements in organization, technology and capacity utilization, collectively known as multifactor productivity (MFP) growth — a lack of innovation should show up as slow MFP growth, although MFP growth rates can be slow for other reasons.

Dion attributes the brief spurt in Canadian labour productivity growth between 1997 and 2000 to capital deepening and MFP growth that resulted, first, from the information and communications technologies (ICT) boom and, second, from cyclical factors. The increase in ICT investment increased capital per worker (capital deepening), which increased labour productivity. The ICT boom also increased capacity utilization in ICT-producing industries, which resulted in an increase in MFP in those industries. Other sectors of the economy also experienced MFP growth, as they were able to use their existing capital stock and labour force to expand their output (Dion 2007, 22). Both the ICT investment effects and the cyclical expansion effects on productivity fell off after 2000.

A Statistics Canada study (2007b) provides further insights by comparing business sector productivity growth rates in Canada and the United States over the longer term (45 years) (see tables 2 and 3). The study finds that, although rates of labour productivity growth in the two countries were roughly the same over the entire period 1961 to 2006, Canada's rate has been lower than that of the United States for the past 26 years and the gap is widening. As well, over the long term, the rate gap is due almost entirely to the much higher rate of MFP growth in the United States. The study also finds that MFP growth was faster in Canada than in the United States between 1996 and 2000 but much slower between 2000 and 2006.

MFP growth is often associated with technological change, organizational change, economies of scale and utilization rates. But, to paraphrase Moses Abramovitz, it is also a measure of our ignorance (1956). In essence, over the period 1961-2006, relative to that of the United States, Canada's labour force improved in quality, and the amount of its capital per worker increased, yet output per hour grew at roughly the same rate in the two countries. For some reason, the US business sector was able to do equally well with less.

Table 2
Change in Labour Productivity in the Canadian and US Business Sectors, 1961-2006 (percent)

	1961-2006	1961-80	1980-96	1996-2006
Canada	2.1	2.9	1.3	1.8
United States	2.3	2.5	1.8	2.8
Canada minus United States	-0.2	0.4	-0.5	-1.0

Source: Statistics Canada (2007b).

Dion explores three possible explanations for Canada's relatively low rate of growth in MFP over the period 1996-2006:

- increased adjustment costs associated with inter-industry shifts in labour and capital due to the change in the exchange rate;
- diminishing returns in the extractive (mining and oil and gas) industries; and
- impediments to innovation.

He concludes that adjustment to exchange-rate changes had a negative effect on productivity growth but it is difficult to measure and that diminishing returns in the extractive industries had a significant negative effect on aggregate productivity growth. He sees both these factors as exacerbating what he calls the long-term drag on MFP growth due to the relatively low level of innovative activity in the Canadian economy (2007, 29).

It is important to understand that, while the rate of MFP growth is sometimes called the rate of technological change, it is influenced by many factors and these can dominate over shorter periods of time. In their study of the sources of MFP growth in Canada, Baldwin and Gu (2007) find that, over the period 1961-2002, the rate of sectoral MFP growth (based on value added) varied from 2.02 percent annually in the information and cultural industries sector to -2.48 percent annually in the professional, scientific and technical services sector. Observed negative rates of growth in MFP in some sectors are a little hard to square with the interpretation of MFP growth as technological change (what is "negative technological change"?). Baldwin and Gu suggest that negative MFP growth rates in some sectors might be methodological problems with the measurement of output. It has also been suggested that negative MFP growth in the mining and oil and gas extraction industries could be due to the use of lower-quality resources (such as the oil sands). Of course, Canadians are still better off if the output of this industry (crude oil, for example) can be sold on international markets at commensurately higher prices.

As far as the real income of Canadians is concerned, an improvement in our terms of trade (what our exports will buy on international markets) is as good as an improvement in technology. While MFP growth has lagged in Canada, we have done extremely well in recent years on the terms-of-trade front (see Kohli 2006). Indeed, as Macdonald (2007, table 2) reports, Canada's real gross domestic income (GDI) per capita — what we can buy with what we produce — increased much faster than US real per capita GDI over the 2002-06 period.

Table 3
Sources of the Disparity in Labour Productivity Growth Rates between Canada and the United States, 1961-2006 (percent change)

	1961-2006	1961-80	1980-96	1996-2000	2000-06	1996-2006
Labour productivity growth gap (Canada minus US)	-0.2	0.4	-0.5	0.4	-1.9	-1.0
Capital deepening	0.4	0.7	0.2	-0.1	-0.1	-0.1
Labour composition	0.2	0.4	0.0	0.2	-0.1	0.0
Multifactor productivity growth	-0.8	-0.8	-0.8	0.3	-1.8	-0.9

Source: Statistics Canada (2007b).

We need to exercise caution before going into crisis mode, but according to the best available evidence, the rate of growth in labour productivity in the business sector has been lower in Canada than in the United States for a fairly long time, due in large measure to Canada's slower rate of MFP growth. A number of factors could be in play, but one can reasonably conclude that its relatively lower rate of MFP growth over the longer term reflects a slower pace of organizational and technological change than in the United States.

The Innovation Problem

The ultimate result of innovation is MFP growth, but there are many kinds of innovation and they are difficult to measure. Innovation does not have to be technological in nature and it does not have to involve formal R&D. As Nathan Rosenberg wrote years ago, a great deal of innovation is the accumulation of small, unremarkable process improvements. These innovations reduce the costs and increase the profits of the firms that make them but they might not be announced or even be countable.

There are, however, proxy measures or indicators of innovative activity. For example, a rough distinction can be made between innovative output that is potentially commercial (proprietary science) and innovative output that is freely accessible (open science, generally the product of research in universities and public research institutes). A further distinction can be made between input- and output-based measures of innovation. Measures of commercial innovative output include patents granted, triadic patents granted, patents granted and cited, royalty and licensing income, world-first innovations introduced, national-first innovations introduced, sales revenue from world-first or national-first innovation, the number of new start-up firms, growth of start-up firms and initial public offerings of innovative start-ups and exports of high-tech or R&D-intensive products.[2] With respect to open science, common measures of output are peer-reviewed publications, publications in highly ranked journals and both academic and commercial citations. Business use of open science — for example, as indicated by citations of scholarly publications in patent applications — is sometimes referred to as "indirect commercialization" (Australian Institute for Commercialisation 2003). The number of graduate and undergraduate science and engineering degrees awarded can also be viewed as a measure of innovative output. Common input-based measures of innovative activity include employment of scientists and engineers, spending on R&D and investment in advanced manufacturing technologies and information technologies. All these measures are normalized to take account of the size of the industry or economy involved.

International comparisons of innovative activity

Canada is among the several countries that have conducted surveys of commercial innovation. Therrien and Mohnen (2003) compare the results of five national surveys of innovation conducted over the period 1997-99, and find that Canadian firms are more likely to be innovators but derive a smaller fraction of their sales from innovations than firms in Germany, France, Ireland and Spain. They note:

> Canada leads the pack by far if we consider the percentage of innovating firms in the respective country samples, however it ranks last if we consider the share in sales of innovative products. It is also among the best, but no longer outdistancing them, if the criterion of performance is the percentage of first-innovators, and again it trails if the criterion is the share of innovative sales among first-innovators. Unfortunately, quantitative data on the share of sales specifically due to first-innovation is not available in Canada. (2003, 368)

One way to gauge innovative activity is through the use of triadic patent intensity measures. A triadic patent family is formed when patent applications for the same invention are filed in Europe, Japan and the United States. Triadic patent intensity can be measured in a variety of ways, including the ratios of patents to gross domestic product (GDP), to gross expenditure on R&D (GERD) and to business expenditure on R&D (BERD). In 2005, Canada ranked fifteenth of 30 OECD countries in triadic patents per dollar of GDP, seventeenth in the ratio of patents to GERD and fifteenth in the ratio of patents to BERD.[3] It appears that, by these measures, Canada's rankings are due less to its relative R&D intensity than to the nature and patentability of the R&D that is done in this country. When it comes to triadic patents, at least, Canadian R&D performers do not appear to be getting a particularly big bang for their buck relative to those in other OECD countries.

A number of countries, including Canada, track indicators of the commercialization of open science research, including inventions disclosed, patent applications, patent grants, licences executed, licence income and start-ups.[4] In a comparison of national surveys from 2003 and 2004, Arundel and Bordoy find that, despite the difficulty of such comparisons and the volatility of some indicators, Canadian universities and research institutes do better than their counterparts in Australia, the United Kingdom and Europe with respect to patent grants but worse with respect to licence income (2006, table 3). Not surprisingly, US universities and research institutes tend to do best by most measures.

The Council of Canadian Academies has assessed the quality of open science in Canada through a bibliometric analysis of the quality and relative frequency of scholarly publications by Canadians. The council finds that, whether measured by the rankings of the journals in which Canadian research is published or by the proportion of publications accounted for by Canadians, the publications of Canadian researchers are above the world average in most of the 125 fields of research it surveyed:

When the bibliometric data are viewed in their entirety, Canada's broad strength in published research is apparent. We note that:

- For 38 percent of the 125 areas analyzed, both publication quality and intensity were above the world average. In only 10 percent of the 125 disciplines were quality and intensity both below the world average.
- Almost 70 percent of the 125 disciplines had publication quality ratings above the world average.
- In only 11 of the 125 disciplines was publication quality rated at less than 90 percent of the world average. (Council of Canadian Academies 2006, 14)

However, the council mentions some areas of disconnect between academic research strength as measured by bibliometric analysis and areas of commercial strength as measured by technometric (patent) analysis: "Canada's patenting activity is relatively weak in many fields where Canada produces good science. For example, despite excellence in chemistry research, Canada's patenting metrics are below the world average in chemical products, organic chemicals and petroleum-related technologies" (14). The nature of the linkage between bibliometric and technometric quality measures is an obvious topic for future investigation. In addition, the council might wish to extend its peer evaluation to include foreign opinions of Canadian research. It might also be of interest to see whether Canadian quality is above the OECD average rather than the world average.

Turning to input-based measures of innovative activity, various studies (for example, McFetridge 1992; Baldwin and Sabourin 1998) show that Canada has been slower than the United States in adopting advanced manufacturing technologies. Other studies (for example, Institute for Competitiveness and Prosperity 2006, 33; Banerjee and Robson 2007) reveal that Canada has lower levels of investment per worker and investment as a percentage of GDP in machinery and equipment and ICT than the United States. Canada also has a lower ratio of BERD to GDP than many other OECD countries.

With respect to R&D-intensity measures, the story is familiar. Canada ranks in the top four OECD countries with respect to its ratio of nonbusiness R&D to GDP but fourteenth in its BERD to GDP ratio, which pulls its GERD-to-GDP ranking down to twelfth among OECD countries. Another way of putting it is that Canada ranks nineteenth among OECD countries in the fraction of its R&D spending accounted for by business (its ratio of BERD to GERD) (OECD 2007, tables 1, 23 and annex 2, table A).

Assessments of the indicators

Canada's undistinguished standing in international comparisons of indicators of commercial innovation and its mediocre MFP growth record support the view that the relatively slow rate of labour productivity growth in this country is attributable, in part, to a relative lack of technological innovation in the business sector. This concern has been expressed in many quarters over the years, but it now seems to be attracting new attention, perhaps because Canada's productivity growth record has deteriorated in recent years. For example, the Institute for Competitiveness and Prosperity concludes that

> Canada has a significant innovation gap. While not a perfect measure, patenting is a good indication of the innovation gap between Canada and the United States. In both countries, patenting rates are strongest in traded industries, but Canada trails considerably. Another measure of our gap is Canada's poor standing on the World Economic Forum's Innovative Capacity Index. (2006, 42)

Dion (2007, 25) also concludes that Canada's innovation performance has been "sub-par," the result of low demand for innovation rather than lack of ability. After canvassing a variety of indicators, the Expert Panel on Commercialization concludes that Canada is suffering from numerous commercialization and innovation "deficits," that too little of Canada's substantial R&D effort occurs in the business sector and that Canadian businesses need to pursue R&D opportunities more aggressively. It, too, sees the problem as one of the "demand for innovation": "The panel believes that while Canada needs to expand and renew its supply-side measures, it must now focus its efforts on the demand side, reducing the barriers and perceived risks that make businesses reluctant to engage in commercialization" (2006, vol. 1, 2). The Council of Canadian Academies comes to a similar conclusion:

> A central conclusion from the evidence in this report is that Canada has built significant strength in many fields of research and there is optimism that we are gaining ground in several of the newer areas. Based on survey commentaries, and in the view of the committee, we do less well in converting strength in basic science into sustained commercial success. This is a long-standing deficiency in Canada's innovation system which requires resolution for the full benefit of Canada's considerable S&T strengths to be realized. (2006, 25)

As these commentators recognize, the realization of Canada's commercial innovation gap is hardly new. The auditor general's 1999 report cites a series of commentaries that came to this conclusion during the 1990s (Office of the Auditor General of Canada 1999, chap. 19, paras. 19.10-19.11). As long ago as 1970, the Senate Special Committee on Science Policy noted that

> Canada is contributing relatively generously to the international pool of knowledge, both through government research and university research but we have neglected to develop our own innovations. In the light of international comparisons, we must conclude that Canada not only plays a subordinate role in the technology race but stands aside as well from the innovation process. (1970, 133-4)[5]

Concerns about the innovation gap often focus on Canada's relatively low ratio of business expenditure on R&D to GDP. Framing the issue this way is unfortunate, however, in that commercialization is about much more than R&D. A host of complementary inputs is involved. Innovation is about entrepreneurship in its various forms and the rewards to it rather than about R&D per se. As one practitioner has noted, "[t]echnology is often pushed out of organizations but it reaches the market more successfully when it is pulled out by entrepreneurs."[6]

Recognition of the importance of market incentives has come somewhat belatedly. Policies and policy debates frequently have focused on pushing businesses into R&D by various forms of assistance that reduce its cost while ignoring myriad other factors that reduce the profitability of technological innovation relative to other business strategies. Recent assessments of the innovation problem, however, appear to recognize the need to address the demand side — that is, the profitability of innovation, or lack of it.

Impediments to Innovation

By a number of indicators, the Canadian business sector is less inclined to engage in innovative activity than might be expected, given the size and sophistication of the Canadian economy. It is important to understand why this might be. Are the indicators capturing the full range of innovative activity that is occurring? Could it be that, although the measures are correct, some of the causes of the apparent dearth of innovation are beyond the reach of remedial public policies?

Traversy (2004) categorizes explanations of the perceived weakness of commercial innovation in Canada into attitudinal factors, structural factors and marketplace factors. Attitudinal factors include societal and managerial attitudes toward science and innovation. Structural factors include Canada's industrial composition, firm size and ownership. Marketplace factors include market access, rivalry, taxation and regulation.

Attitudinal factors

Attitudinal impediments to innovation can arise at the societal level. Arguments that Canada needs an innovation culture are, in themselves, vacuous and, in any case, as Traversy notes, there are already plenty of cheerleaders. More fundamentally, the political process can become dominated by entrenched interest groups that wish to frustrate change. Governments might talk the New Economy talk but continue to subsidize the old economy.

Science policy is not immune to interest group politics. The Senate Special Committee on Science Policy laid the weakness of industrial innovation in Canada, not at the door of "foreign devils," but at that of the bureaucracy:

> We are left with the model first proposed by the [National Research Council] in 1919 and restated since by most senior science managers in the public service. That pattern...put the emphasis on basic science and fundamental research and denigrated development activities as being of "ephemeral value." It called for government assistance to help universities expand their research and education facilities in order to produce a growing number of well-trained pure scientists. It involved the creation and expansion of government laboratories to provide job opportunities for the increasing supply of scientists and to carry on R&D activities that would, it was hoped, prove useful to the industrial sector. (1970, 151-2)

Echoes of the situation perceived by the Senate Committee in 1970 persist. The Expert Panel on Commercialization (2006), while professing to recognize the demand-side determinants of innovative activity, nevertheless proposes a series of remedial policies, including distinguished professorships, internships, fellowships, scholarships, academic competitions and prizes that would warm the heart of any university vice president.

As for managerial attitudes, it has been suggested that Canadian managers choose the wrong strategies for the businesses they manage, opting for cost containment rather than innovation and upgrading, perhaps because they underestimate the returns on risky research ventures or are not forced to do so by aggressive rivals or demanding customers. A related line of argument is that, in participating in fast-moving innovative markets, Canadian managers are handicapped by their relative lack of business education and experience (Institute for Competitiveness and Prosperity, 2006, 46). In essence, there is a shortage of skilled managers and entrepreneurs. As the Conference Board of Canada has put it, "Commercialization is driven by entrepreneurship. But a consistent message that emerged from our research is the perceived lack of entrepreneurs and deal-makers in this country" (2005, 2).

The argument that Canadian businesses cannot attract managers with the requisite skills, experience and entrepreneurial ability to compete in markets characterized by rapid innovation has been made for many years (see Bourgault 1972, 125). Submissions to the Macdonald Commission expressed concerns about a shortage of skills in a wide range of managerial functions, and the commission expressed the view that entrepreneurial effort might also be misdirected into what it called "paper entrepreneurship" (1985, vol. 2, 108-18). More recently, an examination of the weaknesses of the high-tech community in the Ottawa region found that early stage technology transfers and spinoffs are quite successful but that small firms had trouble growing. This was attributed to the lack of management and commercialization skills as well as management leadership — in short, to the lack of entrepreneurship (Doutrieaux 2004).

The continued currency of the view that the principal constraint on the supply of commercial innovation in Canada lies in the supply, not of scientists and engineers, but of managerial and entrepreneurial skills raises some fundamental questions. If Canada has a chronic lack of capacity for business education, this has to raise questions about the management and organization of universities themselves. The issue surely runs deeper still. One place to look is the rewards and demands of alternative career choices — perhaps the rewards to entrepreneurship are not great enough or the quiet life in the bureaucracy is too attractive. Another place to look is the demand that government regulatory and reporting requirements place on management's time and its ultimate effect on the choice of business priorities and strategies. Turning this around, management might perceive that there is more profit in seeking government favour and protection than in upgrading.

Arguments that Canadian company managers have chosen the wrong — that is, the less profitable — business strategy are a different matter. One such argument is that, since Canadian businesses fail to recognize their own self-interest, it is the role of public policy, either by exhortation or financial inducement, to lead them to do so. If it is true that Canadian managers are unable or unwilling to exploit profitable opportunities for innovation and upgrading but must be pushed in that direction by bureaucrats, politicians and policy wonks, then the Canadian economy is in serious trouble and a lack of innovation might be the least of our problems.

Structural impediments to innovation

It has long been argued that the structure of the Canadian economy militates against commercial innovation. Much of this reasoning stems from a view of Canada as a natural-resource-oriented economy with a small, tariff-protected domestic market. That Canada no longer exists, although its legacy remains. Another version of this argument is that, while the Canadian business sector is innovative, this activity does not show up in conventional indicators such as BERD-intensity.

Structural impediments to innovation are usually thought to include firm size, industry composition and foreign ownership. With respect to firm size, the argument is that, because Canada's local markets and its national market are relatively small by international standards, small firms account for a greater proportion of economic activity in Canada, and small firms are less inclined toward innovative behaviour. The argument with respect to industry mix is that, for reasons of comparative advantage, Canada's industrial structure might be relatively weighted toward industries that are not R&D-intensive (which may or may not also imply that they are not innovative). Foreign-owned firms are seen as an impediment to innovation because they do relatively little R&D in the host country, which implies to some analysts that such firms are not innovative and to others that local R&D-intensity is a poor measure of the local innovative activity of foreign-owned firms.

Firm size

Investment in innovation becomes more attractive the more widely the innovating firm can apply it. This makes innovation less attractive to small firms than to large ones. It is well established that, although some highly innovative small firms become big firms, small firms as a group innovate differently and less frequently than large firms (Baldwin 1997). Although this should not be taken to mean that bigger is always better, innovative activity in a given industry is likely to vary inversely internationally with the proportion of industry output accounted for by small firms.

The role of firm size in explaining international differences in various measures of innovation has been investigated by a number of authors. Baldwin and Sabourin (1998, 27), for example, conclude that the slower rate of adoption of advanced manufacturing technologies in Canada observed in a 1993 survey could be attributed primarily to the smaller size of Canadian markets and plants.[7] Canadian plant managers ranked the need for market expansion at the top of their list of impediments to the adoption of new technology, while US plant managers ranked it near the bottom. Canadian plant managers cited improvements in product flexibility and reductions in set-up time as benefits of new technology more frequently than did US respondents. Flexibility and set-up time are more important for plants operating in small markets.

Baldwin and Gu find that, holding industry group effects constant, the probability of introducing a product or process innovation in Canada increases with firm size (2004, table 4). This implies that differences between Canada and comparator countries in the incidence of product and process innovation could be attributable to differences in average firm size.

Studies of the relationship between firm size and R&D-intensity generally find that the probability of engaging in ongoing R&D increases with firm size. They also find, however, that, among R&D performers, the elasticity of R&D spending with respect to firm size is no higher than one, implying that among R&D performers, R&D-intensity does not increase with firm size. Taken together, these findings imply that differences in BERD-intensity between Canada and comparator countries could be attributable to differences in average firm size. In particular, firms below the size threshold at which a firm becomes an R&D performer might account for a greater portion of sales in Canada, or the minimum size threshold at which R&D becomes profitable might be higher in Canada. The empirical evidence does not imply, however, that there is much to be gained in terms of R&D-intensity by combining two R&D-performing firms into a mega-firm.

Industry mix

Structural explanations for international differences in various measures of commercial innovation often focus on differences in ratios of business expenditure on R&D to GDP.[8] It has long been recognized that differences in aggregate BERD-intensity might be due in part to international differences in the proportion of GDP accounted for by R&D-intensive industries and defence industries (Bourgault 1972, 59-60; Palda 1993, 116-21). In its calculations, the OECD adjusts national ratios of BERD to GDP to reflect the average industrial composition of the G7 countries. This moves Norway up in the rankings considerably, Canada up somewhat and Sweden, South Korea and Finland, in which R&D-intensive industries are more important than in the G7 as a whole, down considerably (OECD 2006, figure 3.3).

In a detailed Canadian study, ab Iorwerth (2005) decomposes the difference between the Canadian and US ratios of BERD to GDP into an intensity effect and an industry mix effect. He finds that, of the 0.88 percentage point difference between the two ratios in 1999, 0.60 was due to the lower research intensity of some Canadian industries relative to their US counterparts and 0.28 was due to R&D-intensive Canadian industries accounting for a smaller share of GDP than their US counterparts.

Among the Canadian industries that are less R&D-intensive than their US counterparts, two stand out: the services sector and motor vehicle manufacturing. With respect to the services sector, Dion (2007, 27) speculates that its low R&D-intensity relative to the US services sector could be due to the relatively small size of local Canadian markets for (nontradable) services and to regulatory and ownership restrictions on entry by major US retailers and wholesalers into Canada. Other possible explanations for the relatively high R&D-intensity of the US services sector include the relative importance of large electronic retailers and wholesalers in the United States and the reclassification of R&D-intensive manufacturing firms as service firms as a result of the offshore outsourcing of their manufacturing operations. With respect to the low R&D-intensity of motor vehicle manufacturing in Canada, the reason seems to be that the industry is integrated within North America and R&D is centralized in the United States, principally in Michigan. There is nothing to indicate, however, that this has handicapped Canadian motor vehicle manufacturing plants relative to their US counterparts. In any event, Canadian policy historically has been more concerned about production jobs and content than about R&D.

Foreign ownership

The effect of foreign ownership on business innovation in Canada has been the subject of debate for many years. The recent empirical evidence suggests that, given size and industry effects, foreign-owned firms in Canada are more R&D-intensive than purely domestic firms but somewhat less so than Canadian-based multinationals (Baldwin and Gu 2004). With respect to innovation itself, Baldwin and Hanel (2003) find that, within the core (R&D-intensive) industry grouping, firm size seems to determine whether foreign-owned firms are more likely to innovate (2003, table 10.15). Baldwin and Gu (2004) find that, holding firm size and two-digit industry effects constant, domestic multinationals are more likely than foreign-owned firms to introduce a product or process innovation in Canada, but foreign-owned firms are more likely to do so than purely domestic firms (2004, table 4). Moreover, both foreign-owned firms and domestic multinationals are more likely than purely domestic firms to use advanced technologies (2004, table 5). The authors take their results to imply that any innovation gap between Canadian firms and firms in other OECD countries "reflects the poor innovation performance of domestically oriented firms in Canada" (2004, 16).

As for the role of foreign-owned firms in Canadian innovation, the evidence from Statistics Canada surveys suggests that such firms are active participants. As Baldwin and Hanel (2003) note,[9]

> foreign-owned firms do not collaborate less frequently than do domestic firms with Canadian partners (customers, R&D institutions, universities and colleges, and other partners). Thus, as far as R&D collaboration is concerned, there is no evidence to support the once-popular argument...that foreign-owned firms do not develop links in Canada and are thus responsible for a truncated pattern of corporate behaviour in Canadian manufacturing. (2003, 286-7)

The best evidence available is that foreign-owned firms contribute to host-country innovation and productivity growth rather than act as a drag on it. They form linkages with other participants in the host-country innovation system and are a potential source of spillover benefits rather than operating as enclaves.

Marketplace factors

In discussing the effect of marketplace factors on innovation, Traversy (2004) makes the obvious but underappreciated point that commercial innovation is market driven and that the characteristics of markets for innovation should be a central rather than a peripheral concern:

> Why are marketplace issues of more than passing interest to advisors on commercial innovation? The reason is that, of all the factors in the commercialization mix, perhaps none has grown in recognition over the past decade more than the importance of well functioning markets. At one level, of course, this is trite, or even tautological, because growing, profitable sales are the litmus test of innovation. Put another way, it has long been accepted that innovation must, ultimately, be market-driven. Despite this recognition, though, trade and marketplace policies have largely been treated as outside the purview of industrial innovation. This is no longer appropriate. (9)

Traversy goes on to suggest relevant marketplace issues, including effective access to international markets, market rivalry, market integrity (uncertain rules regarding regulation, proprietary rights and the limits on collaboration), and rules regarding international markets in the services sector. Taxation is an obvious addition to this list.

Canada's participation in the liberalization of international trade has improved the access of Canadian firms to foreign markets and increased competition in domestic markets. Considerable room remains, however, for improving effective market access and reducing restrictions on the international mobility of human and financial capital. For example, restrictions on foreign ownership have been cited as inhibiting technological progress in telecommunications markets, and the tax treatment of foreign venture capital funds has reduced the supply of foreign venture capital in Canada. On the domestic front, despite some privatization and deregulation, much remains to be done. Relatively little progress has been made in reducing barriers to interprovincial trade. Government monopolies continue to thwart the introduction of new business models and methods. Concerns remain about domestic rivalry, government regulation and taxation.

Students of competitiveness have long stressed the role of competitive pressure from rivals and from customers in stimulating innovation. The Institute for Competitiveness and Prosperity (2006, 46) is of the view that there is not enough of it in Canada. Competition also plays a central role in stimulating innovation in contemporary growth models (Howitt 2007). Empirical work by Conway et al. (2006, table 2) shows that anticompetitive regulation of nonmanufacturing industries inhibits investment in information and communications technologies. These authors also find that anticompetitive regulation of industries that are intensive ICT users inhibits aggregate investment in these technologies (2006, table 3). Conway et al. find that regulation of ICT-using industries tends to be more restrictive of competition in Canada than in 11 other OECD countries, including the United States, Sweden, Finland and Australia (2006, figure 2).

In their search for causes of the relatively low rate of capital investment per worker in Canada, Banerjee and Robson come to the same conclusion about the innovation-retarding effects of regulation and state monopolies:

> Some of the sectors likeliest to yield innovations, competitive products, and rising wages in the years ahead — such as telecommunications, financial services, and healthcare — struggle under regulatory regimes shaped by the economic and political imperatives of the past. Other key supports for the economy, such as transportation infrastructure and the production and transmission of fossil fuels and electric power, are not subject to market pricing and/or have restricted access to funds for investment. (2007, n.p.)

Taxation

When searching for impediments to commercial innovation, taxation is the first place to look. Moreover, consideration of tax issues should go beyond tax incentives for R&D, which, as I discuss later, are very generous in Canada in any case. It is the stance of the tax system as a whole, including personal and corporate taxes, that matters.

Mintz (2007) finds that Canada's effective tax rate on capital for marginal investments was the sixth highest in the world in 2006, although reductions in taxes levied on manufacturing firms will have brought the rate down to eleventh highest in 2007. Mintz argues that the corporate tax rate is above the level that maximizes tax revenue and that, together with capital taxes and sales taxes on machinery and equipment, it deters investment in machinery and equipment (2007, 8-11). New machinery and equipment embodies new technology, increases productivity and is complementary to R&D.

Highly progressive tax rates also inhibit both skills upgrading and entrepreneurship (for a thorough discussion, see Gentry and Hubbard 2005). Mintz argues that marginal tax rates on employment income are almost confiscatory over some income ranges (over 60 percent on incomes between $28,000 and $60,000 in Ontario, for example), which discourages investments in skills upgrading and work effort (2007, 4-5). He also argues (2008) that the structure of corporate tax rates discourages entrepreneurs from growing their businesses. Small Canadian-controlled private corporations (CCPCs) are eligible for a variety of tax benefits, which they lose if they go public or grow beyond a relatively low size threshold. For example, the corporate tax rate on the first $400,000 of a CCPC's profits is about 17 percent (depending on the province), rising to about 33 percent on profits in excess of that amount or if the corporation goes public. Mintz observes that CCPCs can also spin off part of their R&D operations into new CCPCs in order to remain eligible for the 35 percent (refundable) federal R&D tax credit.

Mintz also observes that taxes on savings discourage the accumulation of wealth outside of registered retirement savings plans and pension plans (2007, 5-6).[10] The Institute for Competitiveness and Prosperity

(2006, 37-40) makes similar observations, and calls for a "smart" tax system that taxes consumption rather than savings and earnings.

While Canada has generous tax incentives for R&D, McKenzie and Sershun (2005) show that the effectiveness of these incentives can be blunted if not offset entirely by other business taxes (see also McKenzie 2006). They conclude:

> The obvious implication of these results is that when considering tax policy in the context of R&D governments need to consider not only the impact of direct tax subsidies on R&D, but also the impact of the production tax regime. More precisely, failing to take account of both effects may result in governments giving with one hand and taking away with the other, encouraging R&D by offering generous tax subsidies which lower the cost of undertaking research, but discouraging R&D by imposing high production taxes on the fruits of the R&D, the discovery of new products and processes. (2005, 22)

Instead of reducing tax rates, the federal and provincial governments maintain a panoply of selective tax expenditures and government programs designed to offset the most glaring or politically troublesome adverse incentive effects of these high tax rates. The problem is that it is impossible to anticipate and compensate for the entire range of adverse incentive effects of high tax rates.

Financing Innovation

There is widespread agreement about the role that markets for risk (venture) capital play in promoting and facilitating commercial innovation. There is no agreement, however, as to whether any shortcomings of the Canadian venture capital market flow from its demand side or its supply side or as to whether the policies of the federal government have aggravated or reduced the market's deficiencies.

The OECD ranked Canada third behind Israel and the United States among 28 countries surveyed in terms of venture capital investment flows as a percentage of GDP over the period 2000-03. Canada ranked twenty-fourth, however, in the percentage of venture capital investments accounted for by banks, insurance companies and pension funds, which are the major investing institutions in most of the countries surveyed (OECD 2006, figures 3.7, 3.8). The anomalous mix of venture capital financing in Canada reflects the dominance in the market of tax-assisted, labour-sponsored venture capital funds.

There is a clear consensus among economists that there is an economic efficiency rationale for government support of innovative activities that have a high social rate of return but a noncompensatory private rate of return. Public discussion of the role of government in supporting innovation often takes an entirely different form — namely, that projects with high private rates of return cannot be undertaken because financing cannot be obtained. It is often argued that there are gaps in the capital market and that this represents a market failure that must be remedied by government lending in some form. While there are acknowledged difficulties in financing investments in intangible capital and capital markets may be thin in spots, it is much less clear that this implies a market failure of a meaningful sort: one man's market gap is another's bad investment. The Macdonald Commission (1985) cited submissions claiming both that the supply of venture capital was inadequate and that there was nothing worth investing in. Twenty years later, the Expert Panel on Commercialization stated the same thing:

> Many early-stage firms claim that there is a shortage of patient capital to finance development of their ideas, a problem thought to be particularly evident in regions outside of Canada's major metropolitan areas. Providers of capital, on the other hand, respond that there is a shortage of investor-ready firms (e.g. that too many firms have weak management teams or poor business strategies, or lack general business know-how). (2006, vol. 2, 33)

The panel perceived what it called financing challenges in the seed and start-up phases of firms' operations and in the late or expansion phases, although it conceded that these challenges exist in all countries. According to the panel, the problem in the start-up phase is a dearth (relative to the United States) of "angel" investors, which it suggested could be ameliorated if government served as co-investor with angels. The Conference Board (2005, 7) has suggested that angel investors receive a tax credit on investments in start-up companies.

There appears to be a consensus that the goal of policies to encourage venture capital financing should be to attract smart and experienced money. This raises questions of institutional design that do not appear to have attracted a great deal of attention. Do large tax credits attract experienced investors, those who exploit profit opportunities that would otherwise have gone unrecognized? Are investment decisions by stakeholder committees likely to result in the identification and exploitation of entrepreneurial opportunities?

Carpentier and Suret (2005) look at a Quebec government program to attract angel investors and other sources of outside equity, the Quebec Business Investment Company Program, and find that it did not attract angels and that the firms receiving support performed poorly relative to the average for their industries. The authors view their results as being consistent with the hypothesis that it is the poorer-quality opportunities that seek out government finance (17). Carpentier and Suret conclude that, although it is not clear the program was necessary in the first place, it nevertheless could have been improved by recognizing the essential characteristics of the financing of small and medium-sized enterprises (SMEs).

With respect to expansion funding, the Expert Panel on Commercialization (2006) concurs with the recommendations of other advisory groups to reduce impediments to participation by US venture capital investors in the Canadian market. One such impediment, section 116 of the *Income Tax Act*, significantly delays the realization of the proceeds of the disposal of shares in Canadian private corporations by foreign investors, a problem that is addressed in the 2008 federal budget (Stikeman Elliott 2008, 3).

The Institute for Competitiveness and Prosperity (2006, 43-5) takes the view that the problem with the supply of venture capital in Canada is not the quantity but the quality.[11] According to the institute, labour-sponsored venture capital funds have attracted unsophisticated individual investors and earned low returns while possibly crowding out more skilled institutional investors. To tackle the problem, the institute advocates changing the mix of venture capital sources by eliminating the preferential tax treatment of labour-sponsored funds. It also joins others in calling for the end of tax impediments to the participation of US venture capital investors in the Canadian market.[12]

Some analysts support a modest role for government in filling the capital market gaps through an appropriately qualified lending agency. A summary of an expert international symposium on funding gaps (Cressy 2002) cites "controversial" evidence that small high-tech firms whose assets are largely intangible might be financially constrained and suggests that there is a role for government if it can mimic the best practices of the venture capital industry and if it focuses on firms likely to generate positive externalities (2002, F13-14). Lerner (2002) advocates government venture capital financing but only to viable firms that promise R&D spillovers. Economic efficiency arguments confine the subsidization of innovative activities to instances in which the social rate of return on investment is high but the private rate of return is insufficient to attract capital. The arguments just cited, however, imply that there might also be a role for the government financing of R&D investments that yield a significant positive externality but are unable to attract investors even though their expected private rate of return is compensatory. Whether these situations are common and whether a government venture capital lender could correctly identify and manage them is another question.

Linking Institutions

Research on national systems of innovation emphasizes the importance of linkages in the innovative process. Key linkages are between innovating firms and their customers, suppliers, competitors and research universities as well as among research institutions. Formal linking organizations include consulting firms, industry associations and research institutes, extension services, university technology transfer offices, business incubators and research parks as well as federal and provincial agencies. Customers are generally thought to play a pivotal role both in facilitating incremental product and process improvements (learning by using) and by requiring suppliers to meet ever-higher quality and performance standards. In some industries (agriculture, for example), suppliers of machinery and equipment and key inputs drive innovation. In general, linkages involve knowledge transfer, which can occur in a variety of ways, including exposure to scientific and technical publications, employee mobility, licensing, joint venturing and reverse engineering. (For a study of the incidence of various types of linkages in Canada, see Baldwin and Peters 2001).

Commercialization of university research is often viewed in terms of patents, royalties or spinoff businesses but it also occurs when students are employed in business in co-op programs, when university faculty and business personnel are interchanged or when commercial users access open science. Perhaps the most important linkage occurs when graduates trained in the newest technology are employed in business. Mike Lazaridis, president of Research in Motion (RIM), stressed the importance of this link in 2004 by noting that, over the preceding 20 years, RIM had hired 5,000 students while licensing only two technologies from universities (quoted in Lougheed 2004, 2).

Historically, there has been concern about the limited linkages between both business and university research and business and government research. The Senate Special Committee on Science Policy (1970) devoted considerable attention to what it viewed as the problem of the isolation and lack of relevance of government laboratories. The Macdonald Commission (1985, vol. 2, 102) noted the lack of business support for university research and suggested that measures be taken to encourage it.

Numerous government programs have been introduced over the years to promote better linkages among formal R&D performers.[13] The Natural Sciences and Engineering Research Council's Research Partnerships Program supports joint research (basic to pre-commercial) and knowledge transfer among universities, science-oriented federal departments and the private sector. The auditor general's 1999 evaluation of the program found that funding decisions took proper account of the scientific merit of projects supported but were unexpectedly thin in terms of both the commercial or pre-commercial significance of the research and the need for funding (Office of the Auditor General of Canada 1999, chap. 19, paras. 19.75-19.90). The auditor general was unable to determine whether industry partners made use of the results of completed projects.

Another federal government initiative intended to support the formation of research networks among university, industrial and other research institutions is the Networks of Centres of Excellence (NCE) program. Introduced in 1989, its objective is to link the academic, private and volunteer sectors to create commercial opportunities (see NCE 2004). The program's annual budget was $82.3 million in fiscal year 2005-06.[14] The auditor general evaluated the NCE program favourably in 1999 (Office of the Auditor General of Canada 1999, chap. 19, paras. 19.92-19.96), and an evaluation on the program's behalf by KPMG Consulting (2002) found that it was successful in achieving its goals and objectives, including knowledge and technology transfer. The evaluation noted, however, that other support programs also encourage linkages, that reporting and application costs were high and that the program sometimes forced linkages. Respondents to a 2006 Council of Canadian Academies survey ranked the NCE program among the top three programs or organizations that support the commercialization of innovation in Canada.

The Expert Panel on Commercialization (2006) recommended further support for linkages between business and universities and other nonprofit institutions in the form of a Commercialization Superfund that would subsidize nonproprietary research in fields in which Canadian businesses could become market leaders. The panel also recommended a program of subsidies to joint research carried out by federal government departments and SMEs.

It is important to separate arguments that linking institutions could be better designed from arguments that their scale should be increased. Experimentation with alternative linking institutions is ongoing in many countries (see, for example, Gulbranson and Audretsch 2008). Whether universities and government laboratories should be more commercially oriented is a whole different question. Some argue for a greater commercial orientation — for example, Stanley (2007) argues that there is insufficient reference to industry needs in current programs supporting academic research, and that some academic research needs to be coordinated with industrial research by a "go to" agency focused on inducing firms to upgrade. Others are wary of viewing the role of universities in the innovation process narrowly in terms of the (direct) commercialization of their research (Conference Board 2005, 2).

Linkages among innovative firms are ubiquitous, and the most important role for public policy is to accommodate them. Since many of the most productive linkages are likely to be international, continuing efforts are needed to reduce barriers to the mobility of human resources and capital. The development of linkages involving government laboratories, universities and the business sector has required more proactive public policies, and this has indeed received considerable attention. The continuing lament that Canada produces good science but seldom commercializes it implies that this linking capability is underused by business. It need not be the case that "if you build it, they will come." Rather than expanding linking capabilities even further, it might be more productive for public policy to focus more closely on the fundamental driver of business participation: the opportunities and rewards for commercial innovation.

Tax Incentives for Business Innovation

The federal government has provided income tax incentives for R&D since 1944 (Department of Finance 1997, 4) and special allowances or credits for current R&D expenditures virtually continuously since 1962. A 1977 study found that Canadian tax treatment of R&D was the most generous in the world at that time (McFetridge and Warda 1977, 76). Since then, many countries have introduced special tax incentives for R&D and some have surpassed Canada's generosity over the years. The federal government has also enriched tax incentives for R&D in various ways over the years, augmented by a number of provincial incentives. An OECD ranking of tax subsidies for R&D as of 2004 put Canada fourth (behind Spain, Mexico and Portugal) of 24 countries (OECD 2006, figure 3.12).

The heart of federal tax assistance for R&D is the Scientific Research & Experimental Development (SR&ED) tax credit.[15] There are currently two rates of SR&ED: a general rate of 20 percent and an enhanced rate of 35 percent for CCPCs with prior-year income under $400,000. These credits are taxable, and there is a ceiling on the expenditures eligible for the 35 percent rate. A partial tax credit, equal to one-half the normal credit, is also available for expenditures on new equipment used primarily for SR&ED in Canada.

Investment tax credits may be deducted from federal taxes otherwise payable. A standard concern about tax credits is that they are of little value to firms with no taxable income. This problem has been addressed in several ways. First, unused tax credits can be carried forward (currently ten years) or back (three years). Second, tax credits can be made refundable — partial refundability provisions were introduced in 1983, and refundability of some sort has been a feature of the tax credit ever since. Currently, the SR&ED credit earned at the 35 percent rate is fully refundable on up to $2 million in current SR&ED expenditures and 40 percent refundable on expenditures in excess of $2 million; SR&ED credits earned at the 20 percent rate are not refundable.

The SR&ED tax credit has both its critics and its supporters. Critics say that, first, since it is generally available, the credit does not direct resources to the innovative activities with the largest spillover benefits. Second, its relative generosity, taken together with the relatively low level of Canada's ratio of business expenditure on R&D to GDP, implies that the credit must have been ineffective in inducing recipients to undertake additional R&D (see Institute for Competitiveness and Prosperity 2006, 45). Third, qualifying for and receiving the credit can be a costly and slow process. Fourth, tax credits earned by foreign-owned firms may be taxed back in part when profits are repatriated to the parent.[16] Fifth, a likely consequence of the marked discrepancy between the 35 percent SR&ED credit available to CCPCs with prior year income under $400,000 and the 20 percent credit otherwise available, together with the ceiling on expenditures eligible for the 35 percent rate, is the fragmentation of R&D operations (Mintz 2008).[17] Some critics (such as Head and Ries 2004; Harris 2005) favour relying more on direct support (subsidies). Mintz (2008) suggests reducing the discrepancy between the enhanced (35 percent) and the general (20 percent) SR&ED credit rates, while the Institute for Competitiveness and Prosperity (2006) favours a tax regime with generally lower taxes on investment, earnings and savings and no special R&D tax treatment.

Supporters of the SR&ED credit maintain that Canada's ratio of BERD to GDP would be even lower without it and that, as a practical matter, the information required to target support to projects with high social rates of return but low private rates of return is seldom available. They also argue that a tax credit program is less costly to administer than a program of direct subsidies, that it minimizes political interference and does not involve the government's picking winners. Some would extend the credit to cover other aspects of innovation and commercialization such as market assessment (Conference Board 2005, 8); others would enrich the credit in various ways, perhaps by extending its partial refundability provisions to corporations other than CCPCs (Wensley and Warda 2007, 1; see also Toms and Watters 2006). Among other things, this would make the SR&ED credit more relevant to the R&D decisions of Canadian affiliates of US-based multinationals.

The ongoing concern about the SR&ED credit and its predecessors is whether and to what extent it induces recipients to increase their R&D expenditures beyond what they would have done in the absence of the incentive. This responsiveness of R&D spending to tax credits is known as "incrementality." Some tax credit regimes focus support on R&D that is deemed to be incremental; that is, R&D in excess of some base amount. Since a dollar of R&D spending ceases to be eligible for a tax credit once it is fully reflected in the base, however, incremental credit or allowance schemes provide less inducement (given the credit or allowance rate) for ongoing R&D spending than do credits or allowances based on the level of R&D spending.[18]

Many attempts have been made to measure the responsiveness of R&D spending to tax incentives. One measure is the "bang for a buck": the additional R&D induced per dollar of tax revenue foregone. An evaluation for the federal Department of Finance (1997) estimates that the SR&ED credit induces $1.38 per dollar of tax revenue foregone and that responsiveness to the credit does not vary systematically by type of recipient. In another study, Dagenais, Mohnen and Therrien (2004) estimate that the SR&ED credit generates 98 cents of additional R&D for every dollar of tax revenue foregone.[19] Dahlby (2005, 53) concludes that responsiveness to R&D tax credits is in the range of $1.00 to $1.38 per dollar of tax revenue foregone.

Another stream of analysis estimates the effect of the SR&ED credit on innovation itself.

Czarnitzki, Hanel and Rosa (2005) find that, when they compare firms that match in all relevant respects except that some receive an SR&ED credit and others do not, firms that receive the tax credit are more likely to introduce new product innovations, world-first new product innovations and Canada-first new product innovations, and to derive a larger fraction of their sales from new product innovations. This difference is sustained even when the sample is confined to innovating firms. Despite their superior innovative performance, the firms that receive the tax credit are no more profitable and do not have a higher market share than nonrecipients.

A qualitative survey of institutions and programs that support the commercialization of innovations ranked the SR&ED tax credit second of sixteen forms of support (Council of Canadian Academies 2006); among business respondents to the survey, the SR&ED ranked first. There is also some anecdotal evidence that the SR&ED credit has been instrumental in the growth of some Canadian firms:

> RIM has also been a constant beneficiary of SR&ED which was described as "vitally important" by Dave Jaworsky, RIM's director of government and university relations. "(SR&ED) is key to our future growth...It justifies everything," says Jaworsky, adding that the program is currently in an "antagonistic mode" that needs to change. "It's an incentive to stay local." (Research Money 2007)

The view of the federal Department of Finance is that the SR&ED (or any other subsidy) is cost effective if it induces a dollar or more of the desired activity per dollar of tax revenue foregone. Dahlby (2005) shows, however, that the issue is not as simple as this. The essential question is whether the subsidy moves resources to a higher-valued use — that is, whether it increases productivity in the broadest sense — which, in fact, depends on the social rate of return on the R&D induced and the value of the activities crowded by the taxes levied in order to finance the subsidy (the cost of public funds). Dahlby finds, for example, that an Alberta provincial R&D tax credit would not be efficient (2005, 55); his analysis could be extended to other provinces and to the federal SR&ED tax credit and to subsidies as well.

Direct Government Support of Business Innovation

The federal government has been offering direct subsidies for industrial R&D since the early 1960s. Of the many programs over the years, the discussion in this section pays special attention to two that have existed throughout the entire period: the Industrial Research Assistance Program and a program for defence and related industries that has gone through several incarnations but for most of the period was called the Defence Industry Productivity Program.

The Industrial Research Assistance Program

The Industrial Research Assistance Program (IRAP), which supports technology development in SMEs, has been operating continuously since 1962. IRAP assistance historically has taken the form of paying the salaries of scientists, engineers, technologists or technicians participating in approved projects. The assistance is generally limited to one-half of project costs.

IRAP is administered by the National Research Council Canada (NRC). Approved projects are supported by an industrial technology advisor employed by the NRC, provincial research councils or other agencies. IRAP expenditures in fiscal year 2005-06 were approximately $145 million, of which roughly half were contributions to nearly 2,700 firms (clients). IRAP also contributes to and coordinates a network of research- and technology-based organizations (National Research Council Canada 2006).

Evaluating IRAP

IRAP has many friends. Respondents to the Council of Canadian Academies' 2006 survey ranked IRAP and the SR&ED tax credit first and second, respectively, in terms of their effectiveness as government programs for commercialization support,[20] with 82 percent of business respondents and 76 percent of all respondents giving IRAP a "strong" rating, some of the highest in the survey (2006, fig. 10). This ranking echoes a long line of informal assessments of IRAP over the past 25 years, which Lipsey and Carlaw (1998, 90-1) found were “almost universally favourable.” Among the reasons given for this favourable evaluation were the expertise and experience of those charged with program delivery and administration, the businesslike manner in which the program was administered and its coordination with other sources of technological information.

More rigorous evaluations of IRAP have come from a variety of sources. In a thorough evaluation of IRAP and other federal commercial R&D support programs, Tarasofsky (1984) expressed concern that IRAP-supported projects might not have been incremental to the firms involved. He also concluded that there was little if any way to assess either the private or social benefits of IRAP-supported projects. He was also (59-60) critical of the methodology adopted in previous evaluations of IRAP, whereby all sales revenue and associated employment was attributed to IRAP-supported projects and then assumed to have been “created” by IRAP. In essence, it was assumed that the resources involved had a zero opportunity cost.

The Office of the Auditor General (1999), in evaluating a number of federal innovation support programs, expressed the general view that, although each program undoubtedly contributed to improving innovation performance, it was difficult to gauge the magnitude of this contribution.

The auditor general examined a sample of 120 IRAP contributions, ranging in amount from $1,000 to $998,000, to firms over the period 1994 to 1999, and found that it was unclear as to whether IRAP-supported projects would have proceeded in much the same fashion without IRAP assistance. The report concluded that “the true incrementality of IRAP support needs further investigation.” It also noted that the business case for the projects was often vague, that project benefits often took the form of jobs “created” and that there were good reasons to believe that the jobs created by IRAP were overestimated (1999, chap. 19, para. 19.17).

Lipsey and Carlaw argue that IRAP has passed the test of what they call “broad incrementality” — that is, that IRAP has succeeded in its goal of altering firms’ R&D capabilities and attitudes toward R&D and improving the diffusion of technological information (1998, 104). In their view, whether the specific projects would have been undertaken in the absence of IRAP support is of less importance, and whether the projects yielding the highest rate of return have been supported is unknowable. Lipsey and Carlaw cite some of IRAP’s laudable characteristics: it supports modest extensions of firms’ technological capabilities rather than attempting dramatic leaps; it has been flexible in altering its methods and objectives in the light of experience; it has supported and facilitated the diffusion of technological information; it has not targeted specific firms or industries; and it has flown below the political radar.

An NRC evaluation of IRAP found that, in 2001 and 2002, NRC-IRAP-funded projects generated an average of 3.2 innovations per project; that NRC-IRAP support generated $11 in sales or equivalent for every dollar of support; and that, from 1996 to 2001, 32,600 additional jobs were linked to NRC-IRAP-assisted innovations, with 12,026 jobs attributable to NRC-IRAP, implying a cost of $3,000 in NRC-IRAP contributions per job created (Gorham 2005, 6). These calculations are again based on the untenable assumption that, but for IRAP, the resources involved in supported projects would have been idle. Gorham cites as IRAP’s strengths that it provides appropriate technological support to SMEs in all sectors and locations in Canada and that it maintains an extensive domestic and international network of partnerships and contacts. Its weaknesses include excessive paperwork and long turnaround times (2005, 7).

An internal review of the fortunes of British Columbia firms assisted by IRAP (clients) reveals that small clients that received assistance over the period 1987 to 1998 tended to grow somewhat faster (in terms of revenue, employment and payroll) in subsequent years than did small nonclients (Statistics Canada 2006, 13). Small-client shareholders equity (paid-in capital plus retained earnings) grew much faster than did that of nonclients. The implications of these findings are ambiguous. While IRAP recipients appear to do better than nonrecipients, it is not clear that the design of this study controlled for differences in the characteristics of firms that apply for IRAP and those that do not. Nor is it clear that all the differences between the results of clients and nonclients are statistically significant. To the extent that these differences are statistically significant, the possibility remains that the observed differential growth has come at the expense of unsupported competitors or potential competitors.

IRAP is probably the most successful federal program that subsidizes commercial innovation. In addition to having highly qualified operating personnel and access to extensive technology networks, it has some commonsense attributes as a subsidy program. A number of commentators have suggested that IRAP should be expanded. Given that much of its success can be attributed to its focus on small firms and small projects, however, there is reason to doubt that the program could be expanded without significantly reducing its effectiveness.

For the most part, the various formal evaluations of IRAP do not help its cause. Assessing IRAP in terms of jobs created, while understandable, raises the question of whether its true objective is to subsidize employment rather than to encourage innovation and productivity growth. Subsidizing employment in favoured firms need not increase productivity — indeed, it might reduce productivity if the employees involved are drawn from higher-valued uses.

The Defence Industry Productivity Program

Federal government support of innovation in the defence and related industries has been provided through a series of programs over the years, beginning with Defence Development Sharing and the Canada-United States Defence Production Sharing Agreement, both of which were initiated in 1959. From 1968 through 1995, support was provided under the Defence Industry Productivity Program (DIPP), which was succeeded by Technology Partnerships Canada (TPC) in 1996. TPC was itself replaced by the Strategic Aerospace and Defence Initiative in 2007.

DIPP's historic emphasis was on maintaining a defence production capability as well as a defence and related civil export capability (Tarasofsky 1984, 27), but its objectives evolved over time. From 1976, until the program's termination in 1995, its ultimate objective was economic growth through exports, while the development of defence-related capability was seen as a means rather than an objective in itself (Lipsey and Carlaw 1998, 35).

DIPP subsidies covered a portion of R&D expenditures, capital investments, costs of establishing Canadian suppliers and cost disadvantages (including foreign subsidies) faced by successful Canadian bidders on foreign contracts. DIPP subsidies were subject to discretionary repayment provisions prior to 1990, when all DIPP assistance became repayable (Lipsey and Carlaw, 37-8).

Evaluating DIPP

DIPP has been the subject of a number of evaluations, the general tenor of which Lipsey and Carlaw summarize as follows:

> DIPP has generally been judged successful when evaluated in terms of its original objective. All the evaluators, including the Auditor General, agree that DIPP maintained and even enhanced Canada's technological capabilities in defence-related industries. However, when evaluated in terms of its economic objective, DIPP has received mixed and often unfavourable reviews. (1998, 41)

Lipsey and Carlaw cite a 1980 assessment by Peat Marwick, which found that 24 of 30 DIPP projects reviewed would not have been undertaken without outside assistance, that DIPP made a significant contribution to the technological capability of the firms it assisted and that DIPP recipients developed related products that would not have been created if the DIPP-supported projects had not been undertaken. When it focused on the net present value of the incremental projects alone and took program delivery costs into account, however, the Peat Marwick study estimated that the economy was less well off by about $97 million (1969 dollars) than it would have been without DIPP (Lipsey and Carlaw 1998, 44). In another study, Tarasofsky (1984) reviewed case files involving well over $200 million in subsidies paid to major DIPP recipients. The supported projects had all just about run their course, and Tarasofsky's evaluation led him to conclude: "[T]he fact of the matter is that a large proportion of the projects were probably failures" (52). DIPP's operation raises challenging questions about the merits, if any, of subsidizing exports and bidding to attract footloose multinationals — questions that are equally relevant to the evaluation of DIPP's successors.

Lipsey and Carlaw evaluate DIPP from the perspective of its effect on the potential technological progressiveness of receiving firms and industries. In their view, subsidies can be incremental and economically beneficial if they induce recipients to be more innovative in general even though they might prove a windfall from the perspective of a single project:

> Structuralists use the broad test because they accept a policy as having incremental effects even if it causes no direct change in technology, as long as it causes a targeted change in the facilitating structure that indirectly encourages technological change. For example, an R&D subsidy may be used as the carrot to induce firms to create research laboratories or to establish closer links with government and university research laboratories. (1998, 13)

The structuralist evaluative framework defines the general characteristics of support policies that result in successful innovation. These include focusing on small changes in technology, being flexible in the conditions and nature of support, allowing for diverse approaches, encouraging interaction between users and suppliers, prioritizing policy objectives but keeping commercial viability paramount, avoiding capture by political interests, disseminating and coordinating information, relying on as wide an array of expertise as possible and promoting rather than suppressing competition (29-30).

Lipsey and Carlaw find that, by structuralist standards, DIPP was a success. The program had the general characteristics of successful innovation support programs. It supported incremental but nonroutine and nonduplicative innovation that was market driven and defence related. It refrained from supporting one firm or technology to the exclusion of others. It attempted to link DIPP recipients with potential customers and to facilitate dissemination of technological and commercial intelligence. In the authors' view, DIPP was incremental because the defence industry was bigger and more R&D intensive than it would have been without DIPP (1998, 43). With respect to externalities, the authors find they are difficult to measure, but the program was set up to encourage them and the Canadian defence industry was thriving (51).

Technology Partnerships Canada

DIPP's successor, Technology Partnerships Canada, was created in 1996, and by fiscal year 2005-06 its total program funding amounted to $300 million. The program was intended to support the development and commercialization of innovative technologies that contribute to economic growth and job and wealth creation. The program paid for up to one-third of the cost of development and commercialization projects in environmental technology, enabling technology — that is, advanced manufacturing and processing technology, advanced materials, biotechnology and selected information technology — and the aerospace and defence industries. TPC-IRAP, delivered by the NRC's Industrial Research Assistance Program, supported SMEs with projects valued under $3 million.

TPC's stated approach was to invest in technology development projects rather than to subsidize them. TPC contributions were intended to be fully repayable in the form of royalties on sales. The auditor general found, however, that the repayment provisions in some TPC agreements were back-end loaded, thereby relegating TPC to the status of a subordinated investor and making full repayment unlikely in some cases (Office of the Auditor General of Canada 1999, chap. 19, para. 19.115). TPC management stated that it restructured repayment provisions so as to balance investment objectives with strategic, wealth-creation and job-creation benefits to Canada (para. 19.116). The auditor general concluded, however, that TPC management should have been clearer about how it interpreted its mandate to take an investment approach (para. 19.117).

Eventually, TPC ran into trouble with the World Trade Organization (WTO), which found that TPC support of the development of Canada's regional jet industry constituted a trade-distorting subsidy inconsistent with WTO rules. To comply with the ruling, Canada was obliged to refocus TPC on promoting technological innovation and enhancing the technological capability of Canadian industry, rather than on commercialization, and to eliminate actual or anticipated export performance as an objective or a consideration (see Foreign Affairs and International Trade Canada 1999). Accordingly, activities eligible for TPC support were redefined to focus on early stage and collaborative R&D and on investment in generic horizontal technologies, in support of companies' overall R&D programs rather than of product-specific technologies. In essence, TPC was to get out of the business of subsidizing both exports and the commercial introduction of specific new products and instead was to focus on supporting the early stage development of technologies of broader application. TPC continued to serve as an investor of sorts, although it was no longer committed to seeking repayment of its contributions in the form of sales royalties. Instead, repayment could take a variety of forms, including implicitly in the form of economic benefits to Canada.

These changes were intended to insulate TPC from further allegations of export subsidization. Allowing for repayment to take the form of benefits to Canada had the merit of responding to concerns of the auditor general and others about repayment and repayment provisions. Insofar as the focus on early stage industrial R&D with broad applications is concerned, one could argue that, if its goal was actually to induce technological innovation, this is where the focus should have been all along. The lesson here for those who are looking for ways the federal government can assist commercialization is that direct subsidization of new products appears to be out.

Evaluating TPC

Although it was much more controversial than IRAP, TPC had some strong client support. A commentary on a conference organized by the publication *Research Money* noted:

> [Dave] Jaworsky [director of University and Government Relations for RIM] also came to the defence of the TPC program, which was recently cancelled by the federal government. He outlined its importance in RIM's

> evolution from a small start-up to a R&D powerhouse with more than 5,000 employees and significant presence in Ottawa and Mississauga as well as its home base in Waterloo. "TPC did what it was supposed to do. It gave us our growth strategy and its future could have an impact on future RIM decisions," he says, adding that it supported the early development of RIM's breakthrough product, the Blackberry. (Lougheed 2007)

In an evaluation of 273 projects administered by TPC and 420 more administered by TPC-IRAP, a report by the consulting firm of Hickling, Arthurs Low focuses on what its authors call the "net economic impact" of TPC, which is essentially the sum of the estimated costs and benefits attributable to the program — in contrast, benefit-cost analysis focuses on the ratio of the value of the benefits derived from a project to the cost of it. The authors conclude that the ratio of company expenditures plus direct and spinoff sales to TPC program expenditures is 8.6; they call this a benefit-to-cost ratio, which it most assuredly is not (Hickling, Arthurs Low 2005, 44).[21] The report assumes that all domestic resources used in TPC-supported projects have a zero opportunity cost.[22] That is, the employees involved would have been sitting at home had it not been for TPC, and even their leisure is assumed to have no value. In fact, the benefit-to-cost ratios it calculates have nothing to do with benefit-cost analysis as it is normally undertaken. While the Hickling, Arthurs Low report is questionable as program evaluation, there is a bigger issue here: if policy-makers and program administrators in Ottawa are basing their decisions on this type of methodology and analysis, it is no wonder Canada has a productivity problem.

Assessing DIPP and TPC

The DIPP and TPC programs were controversial. Both had strong support among client firms. Tarasofsky (1984) judges the DIPP-supported projects he examines in detail to be incremental but economic failures. Lipsey and Carlaw regard DIPP as having been successful because of its design features, because its intention was to create and exploit spillovers and because the defence and aerospace industries in Canada were "thriving" (1998, 51). The report by Hickling, Arthurs Low (2005) finds that TPC recipient expenditures attributable to program support vastly exceeded program costs, although the report's analysis confuses costs and benefits.

Some aspects of these programs were as likely to reduce the efficiency of resource use as to increase it. DIPP was an unabashed export subsidy program, as was TPC until it ran into trouble with the WTO. Both programs were concerned with bidding against other jurisdictions to attract and maintain footloose multinationals. Some evaluations of these programs fail to distinguish between simply using resources and moving resources to higher-valued uses; if DIPP and TPC administrators used the same evaluative criteria to award subsidies, the result could well have been to reduce productivity.

There also appears to have been some confusion as to whether DIPP and TPC were intended to support innovative activities that yield low private rates of return but large domestic spillover benefits or simply to serve as additional investors in certain types of firms. Both DIPP and TPC assistance contained repayment provisions, but these are not necessary for assistance intended to top up private rates of return. Of course, repayment provisions might also have been introduced to forestall a WTO challenge to what might otherwise have been construed as an export subsidy.

DIPP and TPC assistance (plus SR&ED credits) might still be regarded as the price of admission to what Harris (1985) has called a Schumpeterian industry, which yields high profits to domestic shareholders and high wages to domestic workers. According to this strategic industrial policy view, the gain to domestic shareholders and workers from favoured participation in Schumpeterian industries can exceed the subsidies they receive from taxpayers at large. The validity of this argument is questionable, however, in a world in which other countries offer similar subsidies and in which home-country firms might not be domestically owned and might outsource or relocate their activities internationally.[23]

Ironically, the closest TPC came, at least on paper, to a design that generates and exploits innovation spillovers was the 1999 refocus on early stage and collaborative R&D and investment in generic horizontal technologies rather than product-specific technologies. In addition to being less likely to provoke a WTO challenge, a subsidy program that followed these criteria would have many defenders among students of the economics of innovation. There would still be a problem, however, in squaring these program design criteria with the subsidy requirements of TPC's long-time clients in the aerospace and defence industries.

TPC was terminated on December 31, 2006, and replaced by the Strategic Aerospace and Defence Initiative, "a fully accountable research and development...initiative to promote excellence and accelerate innovation in Canada's aerospace, defence, security and space... industries." This is a repayable contribution program administered by Industry Canada's Industrial Technologies Office (Industry Canada 2007). The design of the new program appears to reflect not only the political inevitability of continued subsidization of the aerospace and defence firms that have been long-time clients of DIPP and TPC but also a determination to do so at the lowest attainable budgetary cost.

The role of direct government support of commercial innovation

Canada makes relatively little use of direct subsidies to business innovation. According to the OECD (2007), 2.2 percent of Canada's business expenditure on R&D was financed by government in 2004, placing Canada near the bottom of OECD countries, well behind the United States at 9.7 percent but ahead of Switzerland and Japan. To improve Canada's ranking, some commentators suggest increasing R&D subsidies to business either in addition to, or in place of, R&D tax credits. The Expert Panel on Commercialization (2006) recommends, for example, new or expanded fellowships to employ undergraduate, graduate and postdoctoral students and recent graduates in the business sector and a program to fund research partnering between science-based government departments and SMEs on topics of mutual interest.

Yet, international comparisons of direct government support for business innovation are somewhat hazardous. The Macdonald Commission (1985, vol. 2, 103-4) noted that "direct support" can entail outright subsidies, tied subsidies, repayable contributions or government contracts (which might assign rights in innovations developed under contract to the government). The degree of actual subsidization can vary from country to country depending on the nature of the subsidy regime, and some regimes might not be as generous as they appear. There has also been a general trend among OECD countries away from direct, firm-specific R&D support toward a greater emphasis on innovative outcome or merit-based support of networks and clusters (Gillespie 2007). One reason for this might be that direct support of the commercialization of a new product is likely to be construed as a trade-distorting subsidy and thus run afoul of the WTO and other international trade agreements. Indeed, an OECD survey finds that the effectiveness of direct support of innovation in other countries is mixed, with more frequent success among programs aimed at small firms (2006, 73) — a finding echoed in Canada, where IRAP, which caters to SMEs, is more widely regarded as being successful than DIPP and TPC were.

The federal government has used a variety of direct R&D subsidy programs over the past 40 years. Tarasofsky (1984, 40) finds that the decision criteria of the Economic Development Program (EDP), for one, had little to do with innovation and still less to do with spillovers. Lipsey and Carlaw (1998, 83-4) conclude that a series of other subsidy programs, the Program for the Advancement of Industrial Technology, the Industrial and Regional Development Program, the *Industrial Research and Development Incentives Act* and EDP, were clear failures on the grounds of vague decision criteria and a lack of evidence that the projects they were supporting were worth doing.[24] It is fair to say that, with the exception of IRAP, federal direct support programs for business innovation have been burdened by multiple objectives and support criteria, including job creation, regional development, export promotion, import substitution, bail-outs, Canadianization and plain old political pork barrelling, which has limited their effectiveness in promoting innovation and productivity growth.

There has been a good deal of discussion as to whether it is realistic for governments even to try to target subsidies at projects with high social returns but which the private sector would not undertake on its own. Klette, Mren and Griliches, who confess that the problem is "all very difficult," discuss a number of qualifications to the spillover justification for subsidization (2000, 487-92). On the empirical side, four of the five programs they review had a positive effect on the performance of the firms that were targeted. The authors concede, however, that this conclusion could have been due to selection bias and, with one exception, it applies to the private rather than the social rate of return. If *ex post* subsidy evaluation is "very difficult," there would not appear to be much hope for *ex ante* subsidy fine tuning.

It is possible to design innovation subsidy programs to have a greater chance of improving productivity, even if they fall well short of ideal. The design criteria suggested by the structuralist and national innovation systems approaches can be helpful in this regard. Guiding principles include technological improvement as the overriding program objective; focusing on market demand pull rather than technology push; focusing on incremental rather than discrete technological changes; allowing for multiple technological approaches; sharing information and avoiding capture; and supporting collaborative development in the area of multipurpose or generic technologies.[25] This is some distance, however, from addressing the perceived lack of commercial innovation in Canada, which is frequently viewed in terms of metrics such as new product introductions. In this regard, some argue that, if commercialization is the problem and business subsidies are the chosen policy response, they would have to cover more than just the upstream R&D component of the commercialization process (Institute for Competitiveness and Prosperity 2006, 47).

Subsidies versus tax credits

Proponents of the greater use of subsidies argue that they can be directed toward innovative activities most likely to be incremental and to yield the largest positive externalities. Some proponents also concede, however, that the extent of the positive spillovers resulting from individual innovations is difficult to predict.

As far as incrementality is concerned, some attempts have been made to estimate the R&D bang for a buck of government subsidy econometrically. While dated, these studies found that, in some cases at least, the subsidy programs in existence at the time did elicit additional R&D (see McFetridge 1977, 70-1; Tarasofsky 1984, 79). A more broadly based evaluation of the IRAP, NCE and TPC programs, as well as NRC's Research Partnerships Program (Office of the Auditor General of Canada 1999, chap. 19, para. 19.36), concludes that these programs undoubtedly contributed to improving innovation performance, although it was not possible to tell how much.

Recent work by Bérubé and Mohnen (2007) using Canadian data finds that, among firms equally likely to apply for an R&D grant, firms that receive both grants and tax credits introduce more world-first innovations and derive proportionately more sales revenue from new product innovations than firms that receive tax credits only (see table 4). Grants appear to have the largest effect on the likelihood of introducing world-first innovations, which, the authors argue, are more likely to generate positive externalities. This leads the authors to conclude that R&D grants are going where economic efficiency considerations suggest they should — that is, to support innovations yielding the highest positive externalities (2007, 17). The authors note that they do not have the data to take the next empirical step of estimating the respective marginal effects of tax credits and subsidies on innovation.

While there is evidence that federal innovation subsidy programs have done some good, this is a very weak test, and it remains unknown whether these programs could pass the test Dahlby (2005) poses for tax incentives. Whether tax incentives or subsidies, when the cost of financing these programs is taken into account it might not be enough merely to find that these programs did some good. Subsidies, however, appear to have a clear advantage over tax incentives in two areas. The first is in programs like IRAP, which bundle assistance with professional services and focus on smaller enterprises. The second is in the support of collaborative R&D efforts to link public, nonprofit and for-profit organizations. With respect to commercial innovation, the experience with TPC implies, first, that, notwithstanding idealized program design criteria, spillover benefits are likely to be a minor consideration in practice and, second, that direct subsidization of commercialization in any traded goods industry will invite a challenge under the WTO. As far as support of commercial innovation by larger firms is concerned, tax incentives appear to be the only option.

Table 4
Innovations According to Type of Assistance Received by Firms (percent of firms)

Outcome variable	Tax credits only	Tax credits + R&D grants	*P*-value
Province-first	63.00	69.95	.0618
Canadian-first	48.81	57.14	.0162
North American-first	34.30	41.35	.0638
World-first	17.10	27.36	.0007
New innovation > 0	75.98	87.03	.0001
New innovation > 2	57.90	69.90	.0001
Revenue from new innovation	52.40	65.65	.0001
Revenue from innovation already on market	46.42	47.43	.7548

Source: Bérubé and Mohnen (2007, table 6).

Conclusions

In many ways, the Canadian economy has been doing better than ever. Unemployment and inflation rates are low. Our terms of trade with the United States and much of the rest of the world have improved dramatically. We can finally afford decent restaurants and hotels when we travel abroad. How bad can things be?

Productivity growth is an abstract concept and innovation even more so. The average citizen sees plenty of innovation, whether it is new products in the stores, new services being offered or new businesses opening. For many of us, struggling to program our DVD players and dreading the inevitable next round of personal computer software updates, the rate of technological change is plenty fast enough.

Public policy discussions are replete with assertions of gaps of various kinds and, of course, complaints of "underfunding." It is not unreasonable to suspect that the productivity and innovation "crises" are just the latest preoccupation of the chattering classes — "innovation angst," as Traversy (2004, 17) calls it. The assertion that there is an innovation crisis might also be a pretext for rent seeking, the political response to which is likely to involve yet another round of "stakeholdering" with payoffs to the usual interest groups.

Having said all this, the best evidence we have is that Canada's rate of growth in multifactor productivity — a good summary measure of how well we use the resources available to us — appears to have been below that of the United States for an extended period of time. As well, a number of indicators of varying relevance and persuasiveness imply that Canada's business enterprise sector is not particularly innovative by international standards. This, too, has been the case for an extended period. Much of this comes down to the relatively low ratio of business R&D spending to GDP (BERD-intensity) in Canada: the BERD is the word.

Canada's relatively low BERD-intensity has vexed policy-makers for more than 40 years. It has evoked a series of institutional responses, the nature of which should not be surprising given that, as Traversy observes, the agenda has been set by "government policy wonks and tenured academics" (2004, 17).[26] Science strategies, ministries, councils, advisory panels, boards, committees and an impressive array of programs have come and gone while the perceived innovation gap between Canada and other advanced economies continues to be described in much the same terms today as it was 40 years ago. Among the reasons for this are, first, that part of the perceived innovation gap might not be amenable to remedial policies, at least not to short-term fixes. Second, policies have tended to focus on one aspect of the innovation process: formal R&D, much of it done in a not-for-profit setting. Third, support programs are often flawed in design, administration or both.

Many innovation support programs were unequivocal failures largely because they pursued a multiplicity of policy objectives, some of which were not consistent with innovation or productivity growth. It is much easier to say "jobs, jobs, jobs" than "productivity, productivity, productivity." Other programs were contentious, with strong support (some of it self-interested) in some quarters and equal skepticism in others. Still other programs can be viewed, on balance, as having had some success — perhaps providing something to build on.

There are also doubts about the innovation policy process itself. Program evaluations have frequently been tendentious and methodologically flawed. Programs have been deemed successful if they merely do "some good." This falls well short of making better use of resources, which must occur if these programs are to increase productivity. If progress is to be made, the policy process must somehow develop the capability of recognizing and addressing substandard performance.

A persuasive efficiency case can be made for government support of innovative activities that yield a high social rate of return but an insufficient private rate of return. Yet it is difficult to distinguish such innovative activities from others, and program administrators have had little success in doing so. Indeed, government R&D support programs have often been administered as if they were alternative financial institutions — investing in projects that promise remunerative private rates of return but, for some reason, are underappreciated by the market. The problem with this approach is that the efficiency case for government's filling the capital market gap is much weaker than the case for its subsidizing unprofitable projects with large positive spillovers. Indeed, the federal government might have created a capital market gap itself by offering tax subsidies to poorly performing labour-sponsored investment funds that might have displaced better-informed and -managed sources of finance.

Some lessons can be drawn both from failed policies and from research on the economics of innovation. If business innovation subsidy programs are going to be offered, they should support market-driven, incremental (as opposed to radical) innovation, allow for multiple technological and organizational approaches and provide for the dissemination of any transferable learning that occurs. They should avoid both picking winners and political capture. In many ways, this design fits a program, such as IRAP, that supports innovation in SMEs. Smaller firms are more likely to do R&D occasionally in response to a specific need and to rely on interfirm cooperation for solutions (Baldwin 1997).

Now that the theoretical flirtation with strategic industrial policy has cooled, direct support of larger firms that compete in international markets lacks a persuasive efficiency rationale; in any event, it is likely to be viewed by other countries as a trade-distorting state aid to industry. Such support is defensible only to the extent that it is intended to improve a shared capability, not associated with the fortunes of a specific firm or product. Whether a program that conforms to these specifications can remain relevant and avoid political capture is an open question.

Although strongly supported by the business community, the SR&ED tax credit program (and its predecessors) has been criticized on the grounds that it has not induced additional R&D spending and does not focus support in areas with the highest social rates of return. Both criticisms are unwarranted. As to the first, the SR&ED credit induces about one dollar in business R&D for every dollar of tax revenue foregone, but this effect might well be offset by the various tax disadvantages Canadian businesses face. With respect to the second criticism, it is generally conceded that it is difficult to distinguish among prospective R&D projects on the basis of their expected social rate of return. Moreover, since it is broadly based, the SR&ED credit is not likely to be viewed as a trade-distorting subsidy.

Future policy toward commercial innovation could go in two broad directions. One departs from the past patchwork of specific incentives. It recognizes that, notwithstanding the jargon in the literature on innovation, "we are not building systems — we are creating environments for innovation" (Traversy 2004, 17). It also recognizes that, as far as business innovation is concerned, government policies have been giving with one hand and taking away with the other. The giving has often been either misdirected or mismanaged and the adverse economic effects of the taking away have seldom been taken into account. The new approach would rebalance innovation policy by focusing more on the demand for it — that is, on market incentives for entrepreneurship. This approach, most closely identified with the Institute for Competitiveness and Prosperity, involves reducing taxes on work, savings, investment and risk taking and also reducing market- and competition-restricting regulation. On the supply side, the focus should be on higher-quality venture capital, which means eliminating both tax subsidies for domestic venture capital and tax hurdles for foreign venture capital, and curtailing special allowances, credits and grants (Institute for Competitiveness and Prosperity 2006, 45-7; 2007, 36-45). It is at least arguable, however, that smart taxation could continue to include an R&D tax credit, perhaps with a less progressive rate structure than at present and greater provision for refundability.

The other direction that public policy might take does not depart substantially from the practice of the recent past. This approach acknowledges demand-side concerns, but it remains heavily oriented to the supply side and to the public sector. Despite its apparent recognition that successful innovation must be market led, this approach tends to place more stock in bureaucratic direction and periodic stakeholder exercises. A recent (although certainly not the only) example of this approach can be found in the report of the Expert Panel on Commercialization (2006, 9-27, vol. 1). The panel came up with a flurry of suggestions for new or expanded government programs intended to encourage commercial innovation, together with a commercialization partnership board to advise the government on how to implement these recommendations and to suggest further initiatives. Among the panel's recommendations are:

- new or expanded fellowship programs to employ undergraduate, graduate and postdoctoral students and recent graduates in the business sector;
- scholarships and prizes to winners of high school academic and business skills competitions;
- "Maple Leaf" international scholarships to attract the best foreign scholars to Canadian universities;
- a commercialization superfund to support research and training in university and other nonproprietary laboratories in areas of research in which Canada could become a market leader;
- research partnering between science-based government departments and SMEs on topics of mutual interest; and
- a federally funded, community-based fund that would co-invest with angel investors in new start-ups.

Although universities might well merit greater financial support, and although one could make a case that this should come from federal taxpayers, the panel's recommendations address the commercial innovation issue tangentially at best. Its approach is a variant of the historic "science push" approach of federal science policy, and one that an informed observer recently described as "not only wrong but backward" from a commercialization perspective.[27] It might be the political course of least resistance, but it would do little to improve the climate for entrepreneurship in Canada. If Canadian governments are truly concerned about the innovation gap and serious about reducing it, they will have to face the more politically difficult tax reform and market-opening issues that bear directly on the opportunities and rewards for entrepreneurial activity.

Notes

1 For a thorough discussion of the social rate of return on innovation, see Jones and Williams (1998).

2 For a discussion of indicators of innovation and commercialization, see Conference Board of Canada (2004).

3 OECD (2007, tables 1, 23, 65). Triadic patents are for 2005, GERD and BERD are for 2004 or the most recent preceding year.

4 Therrien (2006) provides a thorough discussion of the indicators of commercialization of R&D in federal government departments and agencies and in hospitals and universities in Canada.

5 In a 1972 study for the Science Council of Canada, Pierre Bourgault said much the same thing: "The achievements of this country in medicine, in nuclear energy and in many other areas indicate that there is no fundamental lack of creativity. We have rather failed to utilize this creativity for the achievement of economic objectives" (124).

6 Laura Kilcrease, managing director, Triton Ventures, quoted in Lougheed (2004).

7 In an earlier study (McFetridge 1992, 36-40), I also found that plant size differences explained part of US-Canada differences in the adoption rates of advanced manufacturing technologies, but that rates in two smaller market countries, Canada and Australia, were quite similar.

8 Structural explanations have also been advanced for international differences in other measures of commercial innovation. For example, in an earlier study (McFetridge 1992, 40-4), I found that a portion of observed US-Canada differences in the adoption of advanced manufacturing technologies could be explained by the industry mix: industries likely to make greater use of such technologies were more prominent in the United States than in Canada. Also, US manufacturers in a given industry were more likely to be involved in defence production, which requires more precision and thus greater use of advanced manufacturing technologies.

9 In their study of the Nordic countries, Ebersberger and Loof (2005) find that, although foreign-owned firms were less R&D-intensive than multinationals based in the host country, foreign-owned firms and domestic multinationals did not differ with respect to various measures of innovative output, including productivity growth. Obviously, foreign-owned firms had access to the technology of parents and other affiliates and did not need to reinvent the wheel. Ebersberger and Loof also find that, in contrast to Canada, domestic multinationals were much more embedded than foreign-owned firms in the host-country innovation system.

10 The Expert Panel on Commercialization laments the lack of angel investors in Canada. Perhaps this is due to the high tax rates imposed on employment income and savings, the effect of which is to leave the government, in one guise or another, as the default angel.

11 Twenty years earlier, the Macdonald Commission (1985, vol. 2, 126) took a similar view, concluding that the supply of venture capital appeared adequate, although too much of it was government managed, and that problems in venture capital markets appeared to arise from difficulties of communication between investors and entrepreneurs.

12 Ontario has announced that it will eliminate its tax credits for investments in labour-sponsored venture capital funds by 2011.

13 For an examination of early attempts to increase the commercial exploitation of federal government R&D by contracting it out to industry, see Bhanich Supapol (1988, 1990).

14 One network the program supports is the Canadian Design Research Network, which seeks to improve productivity by design research (NCE 2006).

15 An earlier experiment with refundable credits, the Scientific Research Tax Credit (SRTC) introduced in 1983, proved to be a tax policy disaster. It allowed R&D-performing firms to sell their tax credits to firms with taxable income. The measure was poorly designed, however, allowing firms to sell credits on R&D they had not done and, in many cases, never would do. The measure ultimately cost the federal government $3.5 billion in tax revenue and was withdrawn in 1985 (Office of the Auditor General of Canada 1988, chap. 17, para. 17.83). According to Palda (1993, 172-5), investors claimed $3.5 billion in SRTCs but only $1.4 billion of this was shown to have resulted in legitimate R&D (some of which would probably have been undertaken anyway). The $2.1 billion excess of SRTCs claimed over R&D performed was essentially a fraud perpetrated on the federal government.

16 According to Garth Issett, vice president, Manufacturing Development Operations, IBM Canada does not make use of the SR&ED credit because it increases the tax liability of its US parent (see Lougheed 2007, 16). This is apparently not an isolated case. According to the Information Technology Association of Canada (2008, 13), there have been numerous instances in which the SR&ED credit is not counted in decisions by US multinational enterprises about whether or not to maintain significant R&D capability in Canada.

17 The 2008 federal budget proposes to increase the ceiling on SR&ED expenditures eligible for the 35 percent credit to $3 million and also to raise the income and asset threshold at which eligibility for the enhanced credit ceases (Stikeman Elliott 2008, 4). This can be viewed as a modest reduction in the incentive for businesses to remain small.

18 The equivalence of incremental and levels-based incentives was indicated by Hughes and McFetridge (1985), who also showed that incremental credit or allowance schemes could induce inefficient cycling of R&D.

19 Other empirical studies (for example, McKenzie and Sershun 2005) show that R&D spending is responsive to marginal effective tax rates on R&D or to the user cost of R&D, but they do not interpret this in terms of bang for a buck.

20 Business respondents to the survey ranked the SR&ED tax credit first and the IRAP program second.

21 The report derives its estimate of the benefit-to-cost ratio as follows. Discounted program (TPC) expenditures were

$3.7 billion. The economic impact of the program expenditures and the company expenditures attributable to the program was $7.8 billion. Impact expenditures appear to be discounted expenditures with import content deducted. The economic impact of estimated direct and spinoff sales was $18.8 billion. Sales estimates were based on anticipated future repayments. Impact sales were defined as exports plus domestic sales due to imports displaced. Domestic sales that did not displace imports were assumed to crowd out domestic suppliers of substitute products and were not counted as a benefit. Nevertheless, estimated consumers' surplus of $5.7 billion on these sales was included as a benefit (which ignores the loss of consumers' surplus on domestic sales crowded out). The sum of the respective economic impacts of program and company expenditures, sales and consumers surplus is $32.3 billion, which is 8.6 times as large as program expenditures (Hickling, Arthurs Low 2005, 30).

22 The report acknowledges that project expenditures do not have what it calls an impact if they are not incremental to the economy, which, it concedes, they rarely are. Nevertheless, it includes them as an impact (that is, a benefit) because it is common to do so (Hickling, Arthurs Low 2005, 28).

23 For a list of the theoretical requirements for successful strategic industrial policy, see Brander (1995). Political economy considerations impose a further set of constraints.

24 Palda (1993, 42-3) and others have described IDRP decision-making as operating on a "garbage can" model.

25 Trajtenberg (2002) suggests principles for the design of R&D subsidy programs based on the experience of Israel, which he regards as having been highly successful.

26 The author is a tenured academic.

27 Kirk Mandy, chief executive officer, Zarlink Semiconductor, quoted in Lougheed (2007, 3).

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Innovation and the Productivity Problem
Any Solutions?
by Donald G. McFetridge

Résumé

Le bilan de la croissance de la productivité au Canada est plutôt médiocre quand on le compare à ceux d'autres pays, ce qui n'a rien de rassurant pour notre futur niveau de vie. On a proposé, au cours des années, de nombreuses hypothèses pour expliquer ce phénomène, et il est vrai que plusieurs facteurs entrent en jeu. D'après une explication qui revient souvent, la fiche décevante du Canada en matière de croissance de la productivité serait attribuable en partie à un manque d'innovation dans le secteur commercial de l'économie. Malgré la mise en place par le fédéral de nombreux programmes destinés à remédier à cette situation, on ne constate aucun progrès appréciable. La présente étude tente de déterminer si les politiques destinées à encourager l'innovation commerciale ont été mal conçues ou mal appliquées, et s'il se dégage de cette analyse des leçons pour la formulation des politiques.

L'étude fait d'abord un survol de la nature et de la gravité du problème de la productivité du Canada. Divers facteurs peuvent l'influencer, et il est difficile de quantifier l'apport de l'innovation à cet égard, tout comme il est difficile de mesurer l'innovation elle-même. De plus, il est possible que l'effet de la faible croissance de la productivité sur le revenu national soit compensé par l'amélioration des termes d'échange du Canada avec ses partenaires commerciaux. Ceci étant dit, les données disponibles indiquent que la croissance de la productivité canadienne est relativement lente et que cela est attribuable, tout au moins en partie, au taux relativement faible d'innovation. Les caractéristiques sous-jacentes de l'économie canadienne jouent peut-être un rôle à cet égard, mais le cadre actuel des politiques publiques y est également pour quelque chose.

Le marché dans lequel évoluent les innovateurs éventuels revêt une importance toute particulière pour les politiques publiques. Les possibilités et les rendements qu'offre le marché — les catalyseurs de l'innovation commerciale — dépendent étroitement, en effet, de son fonctionnement. Au nombre de ces facteurs figurent l'accès efficace aux marchés canadiens et internationaux, la concurrence et l'intégrité des marchés. Il faut notamment se pencher plus attentivement sur l'ensemble du régime fiscal, et non seulement sur les mesures ponctuelles comme le crédit d'impôt pour les activités de recherche scientifique et de développement expérimental (RS-DE). On reconnaît généralement que l'innovation commerciale doit répondre aux besoins du marché, mais les politiques publiques ont plutôt eu tendance à encourager la production de connaissances scientifiques.

Le reste de l'étude est consacré à un examen des données relatives aux effets des politiques publiques destinées à encourager l'innovation commerciale, y compris le soutien accordé aux organismes de financement et à la coopération interinstitutionnelle, les mesures fiscales destinées à appuyer les activités de RS-DE et l'octroi direct de subventions aux activités de recherche-développement.

En ce qui a trait à l'innovation financière, la question demeure à savoir s'il y a des lacunes du côté de l'offre de capital ou plutôt un manque de débouchés pour les investissements. On convient généralement que le marché du capital de risque a besoin de plus d'investisseurs avertis et non pas simplement de plus d'investisseurs : les incitations fiscales ont attiré de nouveaux capital-risqueurs, mais bon nombre d'entre eux se sont avérés peu habiles.

Les politiques publiques au Canada ont beaucoup misé sur les mesures propres à faciliter et à encourager la création de liens entre les laboratoires d'État, les chercheurs universitaires et les entreprises. Cette approche a porté fruit, mais certains analystes font valoir que la principale contribution des universités à l'économie doit résider dans la formation plutôt que dans le développement d'innovations commerciales.

Le crédit d'impôt du Canada en faveur des activités de RS-DE est relativement généreux dans le contexte international. Toutefois, l'intensité en R-D du secteur privé reste relativement faible au Canada. De plus, les autres impôts sur les entreprises neutralisent en partie l'effet de ce crédit. Deux réformes proposées, qui pourraient s'avérer utiles, consisteraient à élargir l'admissibilité aux crédits remboursables et à rétrécir l'écart entre les taux de crédit auxquels ont accès les petites entreprises privées sous contrôle canadien et ceux dont peuvent se prévaloir les autres entreprises.

Bon nombre de programmes fédéraux destinés à encourager l'innovation ont échoué lamentablement, la plupart du temps parce qu'ils poursuivaient toute une gamme d'objectifs stratégiques dont certains n'étaient pas de nature à favoriser l'innovation. D'autres, comme le Programme d'aide à la recherche industrielle, affichent de meilleurs résultats, mais il faut se rappeler que leur objectif consiste à améliorer l'utilisation des ressources plutôt que de simplement procurer des emplois.

L'auteur conclut en affirmant que le défi que doit relever l'innovation commerciale se résume essentiellement à faire en sorte que l'entrepreneuriat ait accès à des opportunités qui lui seront profitables. Si les gouvernements s'inquiètent vraiment de l'innovation au Canada, ils devront aller au-delà des politiques des dernières décennies et adopter des mesures qui risquent de compliquer leur tâche du point de vue politique : abaisser les impôts sur le travail, l'épargne, l'investissement et la prise de risques, et alléger la réglementation qui a pour effet de restreindre les marchés et la concurrence.

Summary

Canada's productivity growth record has been mediocre by international standards, which does not bode well for our future standard of living. Many explanations have been advanced over the years for Canada's lagging productivity performance. A recurring theme is that Canada's disappointing record is due in part to a lack of innovation in the business sector of the economy. Despite the implementation of many remedial federal programs, neither our productivity growth nor our commercial innovation record appears to have improved appreciably relative to those of other advanced countries. This paper addresses the question of whether policies intended to encourage commercial innovation have been misdirected or misapplied and, if so, whether there are lessons for future policy design.

The author begins with a survey of informed opinion regarding the nature and severity of Canada's productivity growth problem. Productivity growth rates can vary for many reasons and the role played by innovation is difficult to measure, as is innovation itself. Moreover, the effect of weak productivity growth on national income may be offset by improvements in Canada's terms of trade with the rest of the world. Given these caveats, the evidence suggests that Canadian productivity growth has been relatively slow by international standards, and that this is attributable in part to a relatively slow rate of organizational, technological and commercial innovation. Some of this may be a result of the underlying characteristics of the Canadian economy, but some is also due to the public policy environment.

Of particular importance for public policy is the market environment in which potential innovators operate. Marketplace factors bear directly on market opportunities and rewards, the drivers of commercial innovation. These factors include effective access to markets both in Canada and internationally; market rivalry; market integrity (e.g., certainty about rules regarding regulation, proprietary rights and restrictions on collaboration). Taxation, in particular, requires more attention, and this goes beyond specific tax measures such as the scientific research and experimental development (SR&ED) tax credit. While it is generally acknowledged that commercial innovation must be market driven, public policy has tended to focus more on encouraging the supply of scientific knowledge.

The author goes on to examine the evidence on the effects of public policies to support commercial innovation, including the support of financing institutions, the support of linking institutions, tax policies supporting SR&ED and direct subsidization of research and development.

On financing innovation, analysts have long debated whether there are "gaps" on the supply side of capital markets or a lack of investment opportunities. The consensus seems to be that the venture capital market needs more "experienced" money, rather than simply more money — past government tax incentives for venture capital investors have attracted new money, but much of it has not proven to be experienced or smart. Some suggest there is a role for government-backed venture capital organizations that can mimic the best practices of private-sector investment banks, but others question the need for a government institution that simply duplicates the work of private-sector counterparts.

A major focus of public policy in Canada has been to facilitate and encourage links among government laboratories, university researchers and the business sector. While this focus has been successful, some analysts caution that the main economic contribution of universities should be education, rather than commercial innovations.

Canada's SR&ED tax credit is relatively generous by international standards, but in spite of this, business sector R&D intensity remains low by the standards of other industrialized countries. In addition, other business taxes may offset the effect of the credit. Two useful suggestions for reform are broadening the eligibility for refundable credits and reducing the discrepancy between the respective credit rates available to small Canadian-controlled private corporations and larger firms.

Many federal grant programs purporting to support innovation, such as the Economic Development Program, have been unequivocal failures, largely because they pursued a multiplicity of policy objectives, some of which were not consistent with innovation or productivity growth. Other programs, such as the Industrial Research Assistance Program, have a better track record, but they must recognize that their objective is to improve use of resources (including human resources), rather than to simply provide employment.

The author concludes that the commercial innovation problem is essentially one of opportunities and rewards for entrepreneurship. If governments are truly concerned about the innovation gap and serious about reducing it, they must depart from the "science-push" approach to innovation of the past 40 years and face the politically difficult tasks of reducing taxes on work, savings, investment and risk taking, and easing market- and competition-restricting regulation.